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Improved Harvest and Desapping Practices Affect Mango Fruit Quality along the Supply Chains

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ABSTRACT

This study was aimed at evaluating the impact of improved harvest and handling practices including careful fruit harvesting along with 4-6 inches long pedicels, de-stemming and de-sapping in 0.5% lime solution, 2-3 min dip and washing in tap water, on the fruit quality of mango along domestic supply chains in Pakistan compared with traditional harvest and handling system prevailing in local mango industry. Six domestic supply chains in two mango cultivars Sindhri and Samar Bahisht Chaunsa were monitored in this regard. The impact assessments were made on the basis of performance against sap burn, skin browning, lenticels spots, rots and physical damage. The effect on fruit skin color and firmness was also studied. Significant interaction of skin browning, sapburn injury, rots and physical damage was found with the practices adopted at farm level. These problems were found to start from farm (origin) and significantly increase along the supply chains depending upon the procedures adopted for produce harvest and handling. The fruits passed through improved practice had significantly better quality at retail with less skin browning (39.17% in improved vs 58.33% in traditional), low sap burn damage (15.83% vs 73.34%), smaller extent of rots (22.50% vs 68.33%) and physical damages (14.17% vs 34.17%). Non significant differences were found among the analyzed practices regarding fruit skin color, firmness and lenticel spots. Overall, the improved harvest and lime desapping technology showed potential as a best practice for the better management of mango fruit quality along the domestic supply chains.

Key Words: Mango fruit quality; Harvest and desapping practices; Supply chains

INTRODUCTION

Mango is the second largest tree fruit crop of Pakistan which remains catering its consumers for about five months (Mazhar, 2007). Pakistan is considered as the world's sixth largest mango producer after India, China, Thailand, Indonesia and Mexico with 5.14% share in annual mango production (FAO, 2008). Sindhri and Samar Bahisht Chaunsa are two most important commercial mango cultivars of Pakistan. In Sindh province, the cv. Sindhri shares about 70% of mango production; while in Punjab province, 55% of mango production is cv. Chaunsa only (Anonymous, 2006). Despite good production, the export of Pakistani mangoes has never exceeded 10% of its production. Furthermore, Pakistan receives the least average unit price (USD 0.37/kg) of any major mango exporting country in the world, well below average returns for countries such as Australia (USD 1.93/kg), China (USD 1.61/kg), and Thailand (USD 0.86/kg). This is mainly due to the poor quality of fruit with very limited shelf life.

Various factors have been correlated with the quality and marketability of the fruits and vegetables including status of maturity at the time of harvest (Malevski *et al*., 1977; Medlicott *et al*., 1990), method of fruit harvesting (Abu-Bakr & Hafiza, 2004), postharvest treatments and handling procedures and the mode of transportation of fruit from orchard to the market (Tucker & Seymour, 1991). The cosmetic look of a commodity is one of the major concerns of the consumers in the market. The acceptance or rejection of the commodity in the market depends upon its external appearance. The importance of aesthetic standards is the topic of many debates worldwide, related to the quality of fruits and vegetables. A widespread belief in the produce industry is that consumers insist on blemish-free fruits and vegetables (Bunn *et al.,* 1990). With poor harvest and handling practices, various kinds of blemishes develop over the fruit skin from field onwards, thus reducing the quality and consumer acceptability. Therefore, for the delivery of competitive commodity in the market and to fetch maximum price, the chances of the incidence of fruit skin blemishes need to be avoided and better management

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practices to be adopted throughout the supply chain (Ledger *et al*., 2003; Hofman & Ledger, 2005).

Traditional harvesting techniques and postharvest handling procedures prevailing in the mango industry of Pakistan drastically plague the quality along the supply chains. Significant volume of mangoes (about 50%) undergoes sap contamination due to poor harvesting methods (Mazhar *et al.,* 2010); while about 25% of the fruit is harvested at improper stage of maturation (Malik & Mazhar, 2007). It contributes towards high economic losses due to poor value at retail. Unfortunately, in the past there has been no research work regarding on-farm interventions, which could add value to the product and help retaining better quality of produce in supply chain. This in turn will give better returns to the stakeholders.

These studies were targeted to conduct a comparative impact analysis of the traditional and improved on-farm harvest and handling practices on the mango fruit quality along the domestic supply chains.

MATERIALS AND METHODS

These studies were conducted during 2008 and consisted of evaluating the impact of two different on-farm mango harvest and handling practices (P1: Traditional practices & P2: Improved practice) at two different stages: Orchard and Retail. For this purpose, six domestic mango consignments (Table I) were monitored from the farm to retail end. Traditional practices included the conventional harvests, followed by collecting in the bamboo baskets, shifting to packing shed and rough packaging in wooden crates. On the contrary, improved practice included careful harvesting of mangoes along with 4-6 inch long pedicels, desapping in 0.5% lime solution [$Ca(OH)_2$; 2-3 min dip] followed by washing in simple tap water (as described by Amin *et al*., 2008). Fruit packaging and all subsequent postharvest procedures (transportation, ripening, etc.) were same for both practices.

Both at farm and retail, 300 randomly picked fruits of both practices (using 100 fruit per replicate) were assessed to study the impact of different practices on physical fruit quality attributes. For assessments at retail, twenty (20) crates containing the fruit of improved practice were tagged (wrapping) with experimental tape and included in each traditional consignment. At retail, the tagged crates were separated to assess the quality in comparison with the traditionally harvested and handled consignments.

The fruit quality attributes used in this comparative impact analysis study included skin color, firmness, skin browning, sap burn, rots, physical damage and lenticels spots. The data was collected regarding all these parameters both at farm level and retail in the fruit of traditional and improved practice. The data was recorded in terms of percent fruit in different extents of each parameter (Table II).

The collected data was subjected to statistical analysis using MStat-C software (Russel & Eisensmith, 1983) under completely randomized design (CRD) with two factor factorial arrangements and three replicates. The means were compared with the application of least significant difference (LSD) test at 5% level of significance (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Statistical analysis of the data ($P \leq 0.05$) indicated significant interaction of various physical fruit quality attributes (i.e., skin browning, sapburn injury, rots & physical damage) with the harvest and handling practices, adopted at farm level.

The fruit harvested and handled according to the prevailing traditional practices in Pakistan had significantly higher skin browning both at farm and retail (15.83 & 58.33% fruit with brown skin, respectively) as compared to the fruits of improved harvest and desapping practice (1.67% at farm & 20% at retail) (Fig. 1a & b). The incidence of skin browning at retail end even in case of improved practice (20.00%) seems to be the negative effect of incorrect harvesting and postharvest handling practices (Anonymous, 2010). Harvesting and packaging under wet conditions (Johnson *et al.,* 1992; Cooke & Johnson, 1994), sap contaminations to the mango fruit skin (Robinson *et al.,* 1993) and suboptimal postharvest treatments (Bally *et al.,* 1997) are the possible causes of skin browning in mango. The bruises, bumps and damages caused by poor packaging and other handling practices i.e., improper palletization and careless transport may also be involved. Such improper practices result in catalyzing the activity of enzymes present in the fruit skin (Menezes *et al.,* 1995), hence causing the skin browning. For the management of skin browning, sterilization of the equipment used in the harvesting and proper handling of mangoes must be ensured. Fruit should never be packed when wet (Johnson & Parr, 2006). Further the use of cardboard boxes instead of traditional wooden crates for the packaging of fruits (as suggested by Anwar *et al.,* 2008) and improvement of transport procedures may also help to avoid the problem of skin browning.

The sap burn injury in the fruit of improved harvest and desapping practice was significantly controlled with result of 95.83% and 84.17% fruit free from sap injury at farm and retail respectively. On the contrary, in case of traditional practice, 69.17 and 26.67% fruit were free of sap at farm and retail, respectively (Fig. 2a & b). No doubt, mango sap injury is superficial but it considerably deteriorates the cosmetic fruit quality and results in poor consumer acceptance and reduced market value (Menezes *et al.,* 1995). The results of this study highlight the importance of desapping as described earlier (Landrigan *et al*., 1991; Amin *et al*., 2008; Maqbool & Malik, 2008).

The improved harvest and desapping technique was also found to significantly reduce the incidence of rots at retail (22.50%) as compared to the traditional practice (68.33%) (Fig. 3a & b). Significantly lesser incidence of body rots in the fruits of improved practice seems to be the

Table I: Details of monitored consignments

Cultivar	Cons. No.	Route		Transit		
		Origin	Destination	Harvest Date*	Arrival Date*	Days
	1	Tando Ala Yar	Sohrab Goth, KHI	6 Jun	10 Jun	4
Sindhri	2	Tando Ala Yar	Retail market, LHR	9 Jun	14 Jun	5
Samar Bahisht	1	Rahim Yar Khan	Sohrab Goth, KHI	6 Jul	9 Jul	3
Chaunsa	2	Rahim Yar Khan	Retail market, LHR	8 Jul	12 Jul	4
	3	Multan	Sohrab Goth, KHI	17 Jul	21 Jul	4
	4	Lodhran	Retail market, LHR	20 Jul	24 Jul	4

*year= 2008; KHI= Karachi; LHR=Lahore

Table II: Categories of studies parameters

Categories	Quality Attributes			
	Skin Colour	Textural Softness	Lenticels/Rots	Sap burn/Skin Browning/Physical Damage
1	0-10%	Hard	Nil	Nil
2	10-30%	Rubbery	<25%	Up to 3cm^2
3	30-50%	Sprung	25-50%	3cm^2 to 25%
4	50-70%	Eating Soft	>50%	25-50%
5	70-90%	Very Soft		
6	90-100%			

Table III: Impact of different practices on peel color, firmness and lenticels of mangoes at farm and retail

Mango characters	Category	Farm			Retail		
		Traditional Practice	Improved Practice	Mean	Traditional Practice	Improved Practice	Mean
Skin color	0-10%	95.83a	98.34a	97.08A	5.83b	12.83ab	9.34
	10-30%	4.17b	1.67bc	2.92B	12.50ab	13.33ab	12.92
	30-50%	0.00c	0.00c	0.00C	25.83ab	20.00ab	22.92
	50-70%	0.00c	0.00c	0.00C	14.17ab	17.00ab	15.59
	70-90%	0.00c	0.00c	0.00C	12.50ab	33.17a	22.83
	90-100%	0.00c	0.00c	0.00C	29.17a	3.67b	16.42
	LSD *(P≤0.05)*	3.517		2.487	22.61		NS
Firmness	Hard	98.34a	99.17a	98.75A	5.00de	8.33cde	6.67C
	Rubbery	1.67b	0.84b	1.26B	25.00abc	21.67bcd	23.34B
	Sprung	0.00b	0.00b	0.00B	25.83abc	25.83abc	25.83AB
	Eating Soft	0.00b	0.00b	0.00B	31.67ab	41.67a	36.67A
	Very Soft	0.00b	0.00b	0.00B	12.50cde	2.50e	7.50C
	LSD *(P≤0.05)*	2.502		1.769	17.62		12.46
Lenticels	Nil	100.00	100.00	100.00	71.67a	83.33a	77.50A
	<25%	0.00	0.00	0.00	22.50b	15.00bc	18.75B
	25-50%	0.00	0.00	0.00	5.83cd	1.67cd	3.75C
	>50%	0.00	0.00	0.00	0.00d	0.00d	0.00C
	LSD *(P≤0.05)*	NS		NS	14.30		10.11

NS= Non-Significant

effect of desapping along with subsequent washing. The mango sap is acidic, sugary, proteinaceous and sticky in nature and has been reported to be associated with secondary pathogenic infections (Menezes *et al.,* 1995; Negi *et al*., 2002; Maqbool *et al.,* 2007). The improved practice of lime desapping along with subsequent washing denatures and washes it away along with various dust particles from the fruit skin, imparting an attractive and clean appearance to the mango fruit and reducing the chances of invasion and proliferation of the spores of various sap associated pathogens (fungi & bacteria).

It was also found that the traditional harvest and handling practices were responsible for physical damage to the mango fruit at the farm (15.00% affected fruit). Further increase in physical damages was also noted at retail in the fruit of both practices (Fig. 4a & b). Occurrence of the physical damage from farm level (site of production) up to the retail clearly indicated that adopting improved practices only at farm level (i.e., careful harvest & desapping) is not sufficient to maintain the quality throughout the supply chain. The mangoes are prone to physical damage at each step of postharvest handling chain (Brecht & Yahia, 2009). Therefore, there is need to follow better management practices at all subsequent steps/stages (i.e., grading, packaging, loading/unloading, transport, market & retail etc.) until the commodity arrives in the hands of consumer. In this study, non-significant differences among both the practices regarding fruit peel color, textural softness and lenticels spots (Table III) showed that improved practice does not have negative impact on mango fruit quality in terms of these parameters as compared to traditional harvest and handling practices. Comparatively less extent of lenticels spots (16.67%) in the fruit of improved practice as compared to the traditional practice (28.33%) further adds to importance of improved practice.

Fig. 1: Mango fruit skin browning in response to traditional and improved practices at farm (A) and retail ends (B)

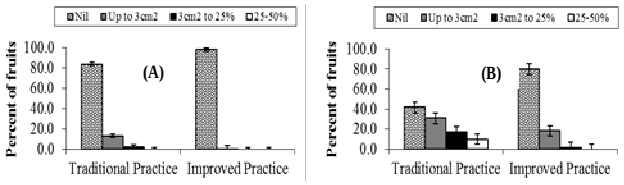


Fig. 2: Mango fruit sap burn injury in response to traditional and improved practices at farm (A) and retail ends (B)

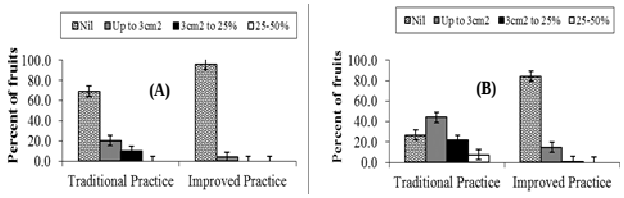


Fig. 3: Mango fruit body rots in response to traditional and improved practices at farm (A) and retail ends (B)

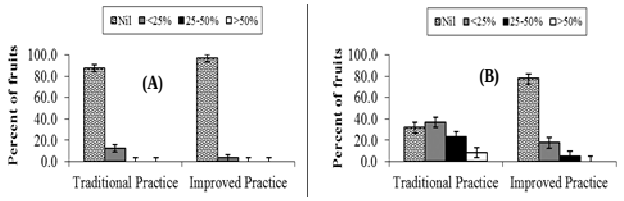
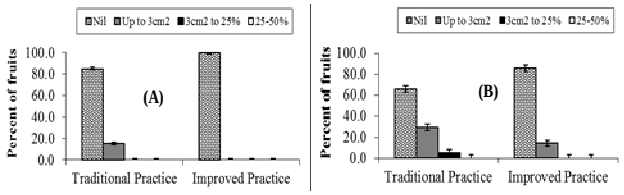


Fig. 4: Extent of physical skin damage in mango fruit with respect to traditional and improved practices at farm (A) and retail ends (B)



CONCLUSION

In order to maintain fruit quality along the whole supply chain, the precautions need to be kept under consideration at all steps from farm (production level) to consumer (consumption level) especially at harvest and transportation. The situation of current supply chain system in Pakistan needs to be improved in order to reduce high postharvest losses and improve the produce quality, its marketability and profitability.

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