Effect of harvesting time and washing treatment on post-harvest quality of mango

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ABSTRACT

To study the quality of mango fruit as influenced by sap burn injury during harvesting time and washing treatment a field research was done in farmer field at KanchanRupa municipality, Saptari and laboratory work at National Citrus Research Program, Dhankuta from 13th June, 2023 to 28th June, 2023. The research was laid out in two factorial completely randomized designs with three replications. The first factor consists of harvesting time (09-11 am, morning time and 02-04 pm, day time). The second factor, washing treatment done in field consists of (No washing, Normal tap water, Sodium chloride - 1%, Potassium metabisulphate- 1%, Detergent- 1%, and Calcium hydroxide- 0.5%). The physiochemical quality, shelf-life, sap burn and physiological loss in weight (PLW) were studied. The highest total soluble solids (TSS) was obtained in No washing (16.63 °Brix) and the lowest in Calcium hydroxide (14.03 °Brix) at 10 days after harvesting. Similarly, the lowest titratable acidity of fruit was obtained in washing treatment with Sodium chloride (0.62%) and highest in both Normal tap water and Calcium hydroxide (0.79%). Among different washing treatments, the longest shelf-life of mango was obtained in Calcium hydroxide (12.10 days) washed fruit followed by Detergent (10.17 days). The shortest shelf-life was obtained in washing treatment No washing (8.25 days). The sap burn injury was recorded more in day harvest (2.03) than morning harvest (1.94) which are statistically not different apart. The PLW of fruit was observed lowest in Calcium hydroxide (7.62%) treated fruit upto 13th days of storage. Overall, Calcium hydroxide was found as best washing treatment for better post-harvest life of mango than rest of the treatments.

Key Words: Mango, physiological property, sap burn, washing treatment,

INTRODUCTION

Nepal is blessed with diverse agro-ecological conditions that favor the production of different horticultural produce. Mango (*Mangifera indica* L.) is a popular fruit in the Nepalese market due to presence of excellent flavor, fragrance, beautiful colour, taste and nutritional properties. Mango is an abundant source of vitamin A, C, E and crucial antioxidants that enhance immunity and nourish skin (Deb *et al.*, 2024). In context of fruit, mango is grown in Nepal in an area of 42,773 ha with production 5,13,055 mt, productivity of 11.99 mt/ha that is lower than productivity of Saptari district 14.84 mt/ha (MoALD, 2022/23). Mango fruit besides local consumption, is an exchange earning commodity in Saptari. The Sap burn injury is considered as most serious problem in fruit quality of harvested mango. The stem

(pedicel) of mango fruit exudes sap which spreads over fruit peel that makes skin damage. Significant volume of mangoes (about 50 %) undergoes sap contamination due to poor harvesting methods (Mazhar *et al*., 2010). Sab *et al*. (2017) also reported 34.49 % post-harvest loss in mango from harvesting to consumption. Abu *et al*. (2021) reported that latex flow in harvested mango occurred even after physiological maturity at decreasing rate which persisted upto packaging. Amwoka (2021) concluded that 5 % solution of lime Ca $(OH)_2$ was best for postharvest loss management in mango rather than that of 10 %, 15 % & 20 % solution. Krishnapillai *et al*. (2016) indicated for the simple, inexpensive, and environmentally friendly method that could be used to reduce sap burn injury in mango. Nowadays growers are interested in production of high-quality fruit due to increase in demand of quality produce. The research was assigned to know the effect of different washing treatment and harvest time on the post-harvest quality of mango fruits.

MATERIALS AND METHODS

The field research was done in farmer orchard at Saptari district (26º 38' 12 '' N; 86º 54' 31''E), Madhesh Province, Nepal. The Saptari district has tropical climate, located at 200 m above mean sea level (masl). The laboratory work was done in National Citrus Research Program, Paripatle (27º 00' 02 '' N; 87 º 18 ' 30 '' E), Dhankuta, Nepal located at 1385 masl.

Each mango tree was applied with 300 gm urea, 400 gm DAP, 300 gm Potash fertilizer in Ring-basin method at the end of Rainy season. Mid-season cultivar Maldah was selected for the research. Mango fruits were harvested at physiological maturity stage with (5–8) cm pedicel attached on the fruit. Then pedicel base was maintained by cutting one cm from the fruit surface. All the harvested fruit was washed in washing treatment for 3-5 minutes in plastic bucket except No washing (Control). Again, sample fruit that has gone under washing treatment was rinsed in normal tap water. The fruit sample was washed in washing treatment within one hour of a harvest. All field work was carried out in an ambient temperature. The sample fruit was laid out in concrete floor with cartoon paper. The washed fruit sample was transported in Bolero Pickup Van from field to Lab in 3 hour and 40-minute time. The temperature and Relative humidity of Lab ranges from 22.7-23.5 ºC and 90-99 % in an ambient room condition.

Experimental details

The experiment consisted of two factors (Time of harvest) and (Washing treatment). The Completely Randomized Design (CRD) along with three replication was done. Each experimental unit / treatment unit consisted 15 fruit sample. Altogether 270 (15*6 *3) mango fruit was washed in morning time. The same quantity of fruit sample was washed in day time at research site.

Time of harvesting (Factor A)

Harvest time (H_1) – Morning time (09-11 am)
Harvest time (H_2)- Daytime (02-04 pm)

Washing treatment (Factor B)

WT_1= Control (No washing)
WT_2= Normal tap water
WT_3 = Sodium chloride (1% Solution)
WT_4= Potassium metabisulphite (1% Solution)
WT_5= Detergent (1%)
WT_6= Calcium hydroxide (0.5% solution)

The data were recorded on 1st, 4th,7th, 10th and 13th days after harvesting (DAH) of mango. The fruit sample were categorized under destructive and non-destructive parameter. Parameter recorded under destructive sample was total soluble solids (TSS) and titratable

acidity (TA). Similarly, under non-destructive sample the parameter recorded were shelf-life, sap burn injury and physiological loss in weight (PLW).

Total soluble solids (TSS) was measured with the help of digital refractometer. Titratable acidity was measured with the help of PAL acid-brix meter. The shelf life of fruits was determined from the days of harvesting to marketable stage till the 50 % of fruit are easily transportable to nearby market. The sap burn injury of mango was assigned by score level (0-4) as given by (Maqbool *et al*., 2007). Physiological loss in weight (PLW) of fruit was determined using the formula:

Physiological loss in weight = [(Initial weight – Final weight)/Initial weight] x 100(%)

The collected raw data was entered and tabulated into MS-Excel (2010), analyzed by statistical software package R studio (Version 4.3.1) by using ANOVA table. Mean values were considered at 5 % significance level ($p< 0.005$)

RESULTS AND DISCUSSION

Total soluble solids (TSS) of mango:

The effect of harvesting time and washing treatments on TSS of mango was analyzed (Table 1). There were no significant differences on TSS at different harvesting time. Similarly, washing treatment at 1 DAH and 4 DAH doesn't have significant difference. At 7 DAH, significantly the highest TSS of 14.54 °Brix was recorded in Normal water than other treatments. At 10 DAH, the highest TSS of 16.63 °Brix was found in No washing treatment which was statistically similar with Potassium metabisulphite and Normal water ($p<0.005$). Amin *et al.* (2008) also reported that control treatment has highest TSS and lowest in lime treated mango fruit. The increase in TSS might be the outcome of conversion of carbohydrate into simple sugar by complex mechanism during the storage which increases with storge period and temperature.

Titratable acidity of mango:

The effect of harvesting time and washing treatments on titratable acidity of mango was analyzed (Table 2). The significant difference of TA with respect to harvesting time was found at 1, 4 and 10 DAH. There was no significant difference at 7 DAH with respect to harvesting time. The washing treatment has significant effect on TA content of fruit in 1, 7 and 10 DAH. At 10 DAH, TA content of fruit was highest in No washing, Normal water, potassium metabisulphite and calcium hydroxide than rest of the treatment. Mounika *et al.* (2017) reported that highest titratable acidity (0.70) % in mango cv. Amrapali treated with 2 % calcium nitrate, and lowest titratable acidity (0.30) % in control. The decrease in acidity of mango is due to conversion of citric acid into sugars and its utilization in metabolic process of fruits.

Shelf-life of mango fruit

The shelf life of mango was recorded based on harvesting time and washing treatments (Table 3). There was no significant difference in shelf-life with respect to harvesting time. The mango fruit treated with washing treatment has significant difference in shelf life ($p<0.001$). The shelf life of mango was observed highest in washing treatment with calcium hydroxide (12.17 days) than rest of the treatments. Mounika *et* al. (2017) reported prolong storage life in Amrapali variety of mango with calcium treated fruit after harvest. Calcium hydroxide or lime helps to maintain membrane integrity, stability in reducing weight loss and anthracnose incidence (Kirby & Pilbeam, 1984).

Sap burn injury in mango

The sap burn injury with respect to harvesting time was scored (Table 4). There is no significant difference in sap burn injury with

respect to harvesting time (Morning time and Day time). Bayogan *et al*. (2021) reported that the Carabao mango cultivar harvested in the morning time showed higher sap injury resulting in lower quality of fruit. Barman *et al*. (2015) reported that mango harvested in the morning (7:00-9:30 am) has lowest sap injury than harvested in the afternoon (12:00-2:00 pm) despite the higher sap volume. The contradiction in finding may be due to growth of different cultivar of mango in different climatic condition.

Physiological loss in weight (PLW %)

Physiological loss in weight generally increased as the storage period advanced, which is slow at initial days and more rapidly after fourth days of harvest (Table 5). At 13th days of storage, the physiological loss in weight was minimum in calcium hydroxide treated fruit (2.54 %) which is not significantly different than Normal water and potassium metabisulphite. Thokchom and Mandal (2018) reported gradual increase in weight loss with storage period in Aonla. Calcium hydroxide treated fruit exhibited minimum PLW in different storage days which might be due to delay of senescence of harvested crops caused by decrease in respiration and desiccation. It has been stated that calcium salts interferes with ethylene link and acts as powerful tool for postharvest management of climacteric fruit (Mounika *et al*., 2017).

CONCLUSION

The results show that washing treatment helps in improvement of fruit quality by prolonging shelf-life, level of TSS and decrease in physiological loss in weight. There is positive interaction between harvesting time and washing treatment. The anti-sap chemical particularly calcium hydroxide yielded satisfactory result. The washing treatment has improved cosmetic look of the fruit.

CONFLICT OF INTEREST STATEMENT

The authors declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Effect of harvesting time and washing treatments on TSS content of mango cv. Maldah

Treatments	Total soluble solids (°Brix)			
	1 DAH	4 DAH	7 DAH	10 DAH
Harvesting time(Factor A)				
Morning time (09 -11 am)	5.48	7.23	12.18	15.36
Day time (02-04pm)	5.38	7.56	12.58	15.77
SEm (±)	0.08	0.23	0.22	0.15
$LSD_{0.05}$	0.23	0.68	0.65	0.43
F-test	ns	ns	ns	ns
Washing treatments (Factor B)				
No washing	5.57	7.96	12.78^{b}	16.63^{a}
Normal tap water	5.59	7.93	14.54^{a}	15.96^{ab}
Sodium chloride (1% solution)	5.55	7.56	12.54^{b}	15.64^{c}
Potassium metabisulphite (1% solution)	5.17	7.28	11.88^{b}	16.25^{ab}
Detergent (1% solution)	5.35	7.14	12.02^{b}	14.88^{c}
Calcium hydroxide (0.5% solution)	5.35	6.58	10.52^{c}	14.03^{d}
SEm (±)	0.13	0.40	0.38	0.25
$LSD_{0.05}$	0.39	1.18	1.13	0.75
F-test	ns	ns	**	***
CV, (%)	5.99	13.29	7.61	3.47
Grand mean	5.43	7.41	12.38	15.57

Notes: DAH: Days after harvest. ns: Non significant at 5% level; ***Significant at 0.1% level;**Significant at 1% level ;SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

Table 2: Effect of harvesting times and washing treatments on titratable acidity of mango cv. Maldah

Treatments	Titratable acidity(TA)%			
	1 DAH	4 DAH	7 DAH	10 DAH
Harvesting times (Factor A)				
Morning time (09 -11 am)	1.09[b]	1.14[b]	0.83	0.77[a]
Day time (02-04pm)	1.26[a]	1.5[a]	0.80	0.71[b]
SEm (±)	0.03	0.04	0.02	0.01
$LSD_{0.05}$	0.07	0.12	0.05	0.04
F test	***	***	ns	*
Washing treatments (Factor B)				
No washing	1.02[c]	1.27	0.75[a]	0.72[ab]
Normal tap water	1.34[a]	1.21	0.86[ab]	0.79[a]
Sodium chloride (1% solution)	1.32[a]	1.4	0.76[bc]	0.68[b]
Potassium metabisulphite (1% solution)	1.21[ab]	1.24	0.83[abc]	0.76[a]
Detergent (1% solution)	1.07[bc]	1.18	0.90[a]	0.74[b]
Calcium hydroxide (0.5% solution)	1.08[bc]	1.63	0.80[bc]	0.79[a]
SEm (±)	0.05	0.07	0.03	0.02
$LSD_{0.05}$	0.13	0.21	0.078	0.07
F-test	***	ns	*	*
CV, (%)	9.50	9.03	8.75	7.58
Grand mean	1.17	1.33	0.82	0.74

Notes: DAH: Days after harvest. ns-Non significant at 5% level; ***Significant at 0.1% level; * Significant at 5% level; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

Table 3: Effect of harvesting times and washing treatments on shelf-life of o mango cv. Maldah

Treatments	Shelf-life (Days)
Harvesting time	
Morning time (09 -11 am)	8.89
Day time(02-04pm)	9.39
SEm (±)	0.26
$LSD_{0.05}$	0.77
F-test	ns
Washing treatments	
No washing	8.25^{c}
Normal tap water	8.33^{c}
Sodium chloride (1% solution)	7.33^{c}
Potassium metabisulphite (1% solution)	8.5^{c}
Detergent (1 % solution)	10.17^{b}
Calcium hydroxide (0.5 % solution)	12.17^{a}
SEm (±)	0.45
$LSD_{0.05}$	1.33
F-test	***
CV, (%)	12.14
Grand mean	9.13

Notes: ns: Non significant at 5% level;***Significant at 0.1% level; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

Table 4: Effect of harvesting times on sap burn injury of mango cv. Maldah at 7 DAH

Treatments	Sap burn injury fruit
Harvesting time	
Morning time (09 -11am))	4 (1.94)
Day time (02-04pm)	4 (2.03)
SEm (±)	0.39
$LSD_{0.05}$	1.29 (0.29)
F-test	ns
Injury (Score)	
No injury	6.54 (2.57)[a]
Very mild	5.83 (2.51)[a]
Mild	5.16 (2.31)[a]
Moderate	1.66 (1.43)[b]
Severe	0.83 (1.12)[b]
SEm (±)	0.68
$LSD_{0.05}$	2.04(0.466)
F-test	**
CV, (%)	41.67(19.34)
Grand mean	4(1.99)

Notes: **Significant at 1 % level; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT. Figure in parenthesis indicate $\sqrt{(x + 0.5)}$ transformation

Table 5: Effect of harvesting times and washing treatments on (PLW %) of mango cv. Maldah

Treatments	**Physiological loss in weight (PLW %) Storage period (Days)**				
Harvesting time	**1**	**4**	**7**	**10**	**13**
Morning time (09-11 am)	0	1.88[a]	2.51[a]	1.99	2.96
Day time (02-04 pm)	0	1.23[b]	2.00[b]	2.19	2.97
SEm(±)		0.09	0.06	0.08	0.06
$LSD_{0.05}$		0.27	0.18	0.25	0.18
F-test		***	***	ns	ns
Washing treatments					
No washing	0	1.42	2.34[ab]	2.31[a]	3.10[ab]
Normal tap water	0	1.40	2.09[bc]	2.13[ab]	2.81[bc]
Sodium chloride (1% solution)	0	1.90	2.35[ab]	2.28[a]	3.26[a]
Potassium metabisulphite (1% solution)	0	1.70	2.31[ab]	1.68[b]	2.84b[c]
Detergent (1% solution)	0	1.65	2.53[a]	2.27[a]	3.23[a]
Calcium hydroxide (0.5% solution)	0	1.28	1.94[c]	1.86[ab]	2.54[c]
SEm (±)		0.16	0.11	0.15	0.11
$LSD_{0.05}$		0.67	0.32	0.43	0.32
F-test		ns	*	*	**
CV, (%)		25.55	12.02	17.58	9.15
Grand mean		1.56	2.26	2.09	2.96

Notes: ***Significant at 0.1% level; ** significant at 1 % level; * Significant at 5% level; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT