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Effect of different organic treatment on the shelf life of Mango (*Mangifera indica* cv. Langra)

Abstract

To increase the shelf life and quality of mango at the mature stage, the goal of this study was to choose an appropriate locally accessible plant extract. Six treatments and four replications in a completely randomized design were used in the experiment. Control, Aloevera extract, Neem extract, Onion extract, Garlic extract, and Ginger extract were the treatments. Thirty-six mangoes were picked for each treatment and stored at room temperature (69.8°F/21°C, day, 64.4°F/18°C night). The findings of this study revealed that alovera extract treatments could increase the shelf-life of mango for 12 days and could be used as an effective farm-based post-harvest treatment to increase the shelf-life, while maintaining the physical and chemical characteristics of mango throughout storing at normal room temperature.

Keywords: plant extract, shelf life, langra variety, organic treatment

Volume 8 Issue 4 - 2024

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Received: August 28, 2024 | **Published:** November 26, 2024

Introduction

Mango (*Mangifera indica* L.) has become a major fruit crop of the tropics and subtropics, particularly in Asia, where the mango has always been the most important fruit crop and where it has been considered the 'king of fruits'.[1] Mango has rich intra specific diversity and there are about 1600 cultivars in the world,[2] of which about 350 cultivars are in commercial production and the rest are limited to mixed orchards or home gardens.

Shelf life of fruits could be extended by precooling, chemical treatments, low temperature different botanicals extracts and so on. For the prevention of post-harvest illnesses of mango, Macias et al.[3] found that natural plant extracts from higher plants that are not harmful to both human health and the environment are preferable to pesticides. Because of their effectiveness against germs and fungi, botanical extracts have gained popularity and the attention of scientists.[4] Extracts of neem, aloe-vera, and garlic have an impact on the shelf life and quality preservation of mangoes. Neem, garlic, onion, potato, mahogani, allamanda, datura, coating with sesame oil, are among the plant extracts that have been found to have some fungicidal activities against a variety of postharvest diseases of tropical fruits that will postpone ripening and lengthen the shelf life. Unlike chemical pesticides, plant extracts have the capacity to degrade quickly and offer no environmental concerns.[5]

Mango post-harvest loss that has increased is a serious issue in Nepal. Health risks are associated with post-harvest treatments that use chemicals and artificial waxes to prevent loss. Thus, this investigation was carried out to evaluate how well the botanical coating improved storage life.

Material and methods

Experimental site and location

This experiment on the shelf life as influenced by different organic coating treatment on mango was conducted at Horticulture laboratory of HICAST. Mangoes were brought from Ghorahi Dang, Nepal, in the normal packing used by farmers to send their product to market. Mature green mangoes were taken for the analysis. The research was conducted from 4 to 15 July, 2022.

Experimental materials

Mango variety: cv. Langra

Botanical coatings

T1 (control, not uncoated), T2 (Aloevera extract), T3 (Neem extract), T4 (Onion extract), T5 (Garlic extract), and T6 (Ginger extract).

Nine fruits for each treatment were randomly chosen and kept in the laboratory at ambient temperature for shelf life and quality assessment. The pulp of botanicals was blended and strained through a clean disinfected cloth, then were submerged in botanical extract for five minutes and finally allowed to air dry for 10 minutes before being placed on the trays for inspection.

Storage conditions

A thermo-hygrometer was used to record the storage room temperature and relative humidity ranges daily; the values maintained during the storage period were respectively 69.8°F/21°C, day and 64.4°F/18°C night and 30 % to 40%.

Measured parameters

The following parameters were measured.

1. Physical parameters

- Firmness, evaluated using a penetrometer.
- Weight lost over time (grams), measured using a digital weighing balance at three days interval

2. Chemical parameters

- Total soluble solids (TSS), measured using a refractometer.
- Titratable acidity (TA), measured using titration method
- pH, measured using a pH meter
- TSS: TA ratio
- vitamin C content, measured by using titration method (Guerrant et al., 1935)

3. Shelf life

- Shelf life of mangoes was calculated by counting the number of days required to fully ripen with optimal eating and commercial quality, which was assessed by a pomologist who judged the acceptability of the mangoes.

Experimental treatment and design

The experiment was laid out in completely randomized design with 4 replications. The effects of the treatments were determined by ANOVA test and the mean separation was done by LSD.

Data collection and statistical analysis

Data was collected and recorded at three days intervals. The collected raw data of the various parameters were entered on MS-Excel for statistical analysis. The means for all the treatments were calculated and analysis of variances (ANOVA) for all the parameters were performed using the R-studio reverse version, a computer-based software. Coefficient of variation and the significance of difference between the pairs of mean was compared by LSD test ($p < 0.05$).

Result and discussion

Physiological weight loss

The results showed the statistical differences between various postharvest treatments. Aloe vera-coated mangos at 9 Days. After Storage (DAS) had the lowest physiological weight lost over time, followed by, ginger-coated mangos, neem-coated mangos and control treatment. Onion, on the other hand, had the highest physiological weight loss at 9th day, followed by garlic-coated mangos (Table 1). This outcome is consistent with the observation of Singh et al.[6] who investigated the effects of GA3, plant extracts, castor oil, and neem oil on mango storage behavior. Primary mechanism responsible for weight loss in most of the fresh produce is transpiration with respiration and other biochemical processes being added.

Table 1 Effect of different post-harvest treatments on physiological weight loss of mango

Treatments	Initial weight	Day 3	Day 6	Day 9	Day 12
T1 (Control)	126.07	15.096 ^{a}	29.25 ^{a}	5.76 ^{bc}	
T2 (Aloevera)	116.76	5.4 ^{b}	11.32 ^{c}	4.14 ^{d}	2.86
T3 (Neem)	125.88	13.18 ^{a}	17.84 ^{b}	5.67 ^{bc}	2.73
T4 (Onion)	125.63	6.63 ^{b}	13.96 ^{bc}	7.80 ^{a}	
T5 (Garlic)	127.06	7.64 ^{b}	12.65 ^{c}	7.09 ^{ab}	2.92
T6(Ginger)	116.25	7.64 ^{b}	14.48 ^{bc}	5.58 ^{cd}	2.86
Mean	122.94	9.26	16.59	6.01	2.847
F-Test		***	***	**	NS
CV (%)		21.8	19.23	16.27	
LSD (0.05)		3.05	4.8	1.47	
SEM±		1.64	2.74	0.600	

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS= Non-Significant CV= Coefficient of Variance, LSD= Least Significant Difference, SEM= Standard Error of the Mean

Change in Firmness

There was no significant difference in firmness change among the treatments. However, Fruit left uncoated (control) showed a tendency to reach the overripen stage quicker followed by the onion coated mangoes and the garlic coated mangoes. More gradual changes were observed in aloevera treated mangoes and neem coated mangoes. Softening of fruits during ripening is characterized by enzyme-mediated alteration in the structure and composition of cell wall, partial or complete solubilization of cell wall polysaccharides (pectin, celluloses and hemicellulose), and hydrolysis of starch and other polysaccharides[7,8] have reported better firmness in Aloe vera coated fruits. Gill et al.[9] also reported softening of fruit pulp with progression of ripening period regardless of ripening temperatures

Table 2 Effect of different post-harvest treatments on change in firmness of mango

Treatments	Day1	Day 3	Day 6	Day 9	Day 12
T1 (Control)	1.10	1.87	2.51	3.04	
T2 (Aloe Vera)	1.25	2.41	2.69	2.76	3.08
T3 (Neem)	1.55	2.64	2.68	2.55	2.99
T4 (Onion)	1.15	2.08	2.77	3.02	
T5 (Garlic)	1.15	2.37	2.59	2.67	3.4
T6(Ginger)	1.25	1.99	2.34	2.72	3.06

Citation: Neupane R, Poudel P, Karki PJ, et al. Effect of different organic treatment on the shelf life of Mango (*Mangifera indica* cv. Langra). *Horticult Int J.* 2024;8(4):95–100. DOI: 10.15406/hij.2024.08.00310

Table 2 Continued...

Treatments	Day1	Day 3	Day 6	Day 9	Day 12
Mean	1.24	2.22	2.598	2.79	3.13
F-Test	NS	NS	NS	NS	NS
CV (%)		18.78	11.79	10.66	7.29
SEM±		0.183	0.0.129	0.137	0.36

significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

Total soluble solid

The study revealed that there was significant effect of the various postharvest treatments on total soluble solid of mango during the ripening and storage process especially on day nine of storage. On this day mangoes coated in neem had the greatest total soluble solids content, followed by control, ginger, garlic and onion, however, Aloe Vera, on the other hand, had experienced the lowest total soluble solids concentration. (Table 3)

Table 3 Effect of different post-harvest treatments on TSS of mango

Treatments	Day 1	Day 3	Day 6	Day 9	Day 12
T1 (Control)	5.20	7.20 ^{a}	8.17 ^{a}	10.68 ^{b}	
T2 (Aloe Vera)	4.30	5.37^{b}	6.53 ^{b}	7.87 ^{d}	10.31 ^{b}
T3 (Neem)	5.20	6.80^{a}	8.40 ^{a}	12.86 ^{a}	11.67 ^{a}
T4 (Onion)	5.10	6.45^{a}	7.53 ^{a}	8.20 ^{cd}	
T5 (Garlic)	5.20	6.16^{b}	7.54 ^{a}	8.50 ^{cd}	11.43 ^{a}
T6(Ginger)	5.29	6.81^{a}	7.46	9.73 ^{bc}	11.76 ^{a}
Mean	5.04	6.46	7.58	9.64	11.29
F-Test	NS	NS	*	***	**
CV (%)		5.61	9.42	10.66	4.18
LSD (0.05)			0.59	1.55	0.75
SEM±		0.276	0.42	0.80	

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

An increase in TSS content form maturity to ripening may probably be due to accumulation of more sugars in the fruits due to hydrolysis of starch from increased amylase activity during ripening.[7] Increase of TSS content observed in the present investigation agrees with the report by Abdullah et al.[10] and Sarker et al.[11] Increase in activity of enzymes responsible for starch hydrolysis might be cause of increase in TSS value during fruit ripening.[12]

pH value

There were significant differences among the various postharvest treatments on pH of mango during ripening and storage process on day 9, the lowest pH was observed in Aloe-vera, garlic and onion-coated mangoes. While the highest pH value was found in fruits of the controlled treatment, followed by neem- coated mangoes and ginger-coated mangoes. (Table 4)

Table 4 Effect of different post-harvest treatments on pH value of mango

Treatments	Day 1	Day 3	Day 6	Day 9	Day 12
T1 (Control)	2.59	3.065^{b}	3.40 ^{a}	3.91 ^{a}	
T2 (Aloe Vera)	2.59	2.89^{a}	2.94 ^{c}	3.18 ^{c}	3.31 ^{c}
T3 (Neem)	2.59	3.03^{a}	3.20 ^{b}	3.72 ^{ab}	3.91 ^{a}
T4 (Onion)	2.60	2.92^{a}	3.16 ^{b}	3.31 ^{c}	
T5 (Garlic)	2.61	2.9^{a}	3.11 ^{bc}	3.28 ^{c}	3.58 ^{b}
T6(Ginger)	2.59	2.97^{a}	3.30 ^{ab}	3.58 ^{b}	3.75 ^{a}
Mean	2.59	2.96	3.18	3.49	3.64
F-Test	NS	*	**	***	***
CV (%)		2.38	3.87	4.2	3.03
LSD (0.05)		0.1	0.18	0.22	0.17
SEM±		0.03	0.076	0.119	

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

The pH of the treated fruits was found to be lower than that of the control set fruits. These results could be attributed to acid oxidation, which is known as a factor leading in greater pH.[13]

Titratable acidity

The study found that the various post-harvest treatments had a substantial impact on the titratable acidity of mangoes during ripening and storage. The control treatment had the highest TA, followed by the mangoes coated in neem and onion at 6 DAS respectively, whereas Aloe-vera coated mangoes had the lowest TA, followed by garlic-coated mangoes and ginger-coated ginger (Table 5). Decrease in acidity with maturity may be due to breakdown of starch into more sugars thereby lowering down the percentage of acidity of the fruits.[14] Moreover, Nordey et al.[15] hypothesized that, climacteric respiration may involve in decline of TA of mango fruit during ripening, since organic acid are substrate for climacteric respiration.

Table 5 Effect of different post-harvest treatments on Titratable acidity of mango

Treatments	Day 1	Day 3	Day 6	Day 9	Day 12
T1 (Control)	0.35	0.19 ^{ab}	0.16 ^{a}	0.11	
T2 (Aloevera)	0.33	0.13 ^{c}	0.118 ^{b}	0.094	0.088
T3 (Neem)	0.33	0.17 ^{ab}	0.136 ^{b}	0.10	0.093
T4 (Onion)	0.32	0.164 ^{bc}	0.136 ^{b}	0.10	
T5 (Garlic)	0.35	0.17 ^{ab}	0.131 ^{b}	0.096	0.092
T6(Ginger)	0.32	0.20 ^{a}	0.125 ^{b}	0.105	0.096
Mean	0.33	0.17	0.135	0.103	0.092
F-Test	NS	**	*	NS	NS
CV (%)		13.8	12.2	9.001	6.14
LSD (0.05)		0.034	0.024		
SEM±		0.012	0.0087	0.0043	

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

TSS:TA ratio

The study revealed that there were significant differences between the various postharvest treatments on TSS:TA ratio of mango during ripening and storage process. At 9th day, the Neem extract treatment had the highest TSS: TA ratio, followed by the ginger coated treatment, the garlic coated treatment, and the onion coated treatment respectively. The controls group had the lowest TSS: TA ratio, followed by the aloe vera coated treatment. (Table 6)

Table 6 Effect of different post-harvest treatments on TSS:TA Ratio

Treatments	Day 3	Day 6	Day 9	Day 12
T1 (Control)	37.75	45.93 b	49.79 c	
T2 (Aloevera)	41.26	48.18 b	79.73 b	116.34
T3 (Neem)	39.64	64.50 a	100.067a	128.07
T4 (Onion)	39.45	63.20 a	80.06 b	
T5 (Garlic)	36.24	57.54 ab	87.78 ab	128.07
T6(Ginger)	33.40	62.55 a	93.63 ab	
Mean	37.95	56.98	81.84	124.16
F-Test	NS	*	***	NS
CV (%)	13.14	14.57	11.64	5.64
LSD (0.05)		12.52	14.36	
SEM±	1.94	4.27	7.49	

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

Shelf life

According to these findings, the study revealed that there were highly significant differences between the various postharvest treatments on shelf life of mango. Aloe-vera extract induced the greatest shelf life, followed by garlic, neem and onion. The ginger treatment induced the lowest shelf life, while mangoes with no treatment had the shortest shelf life (6.0 days) (Table 7). It is likely that by slowing down the breakdown of pectin and starch, the treatment can postpone the fruit ripening.

Table 7 Effect of different post-harvest treatments on shelf life of mango

Treatments	Shelf life (days)
Control	6.000[c]
Aloe Vera	12.00[a]
Neem	10.650[b]
Onion	9.100[b]
Garlic	11.000[b]
Ginger	10.000[d]
Grand Mean F- Test	**9.792 *****
LSD	**0.6321**
SEM (+-)	**0.2125**

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

Table 8 Effect of different post-harvest treatments on vitamin C content of mango

Treatments	Day 1	Day 3	Day 6	Day 9	Day 12
T1 (Control)	2.63	2.53 a	1.41 ab	0.84	
T2 (Aloevera)	1.95	1.52 e	1.29 b	1.55	0.625
T3 (Neem)	2.23	2.2b	1.64 a	1.06	
T4 (Onion)	2.09	1.93c	1.28 b	1.06	0.84
T5 (Garlic)	1.95	1.7 de	1.23 b	1.002	0.6
T6(Ginger)	1.95	1.86 cd	1.33 b	1.01	0.77
Mean	2.13	1.95	1.36	1.02	0.71
F-Test	NS	***	*	NS	NS
CV (%)		6.52	11.72	12.13	23.74
LSD (0.05)		0.192	0.24		
SEM±		0.14	0.08	0.059	

*, **, and *** denote significantly difference at p≤0.05, P<0.01, and p<0.001 respectively; within the column, values followed by the same letter are non-significantly different at 5 % level.

NS, non-significant; CV, coefficient of variance; LSD, least significant difference; SEM, standard error of the mean

The experiment performed by Bhatnagar et al.[16] proved that the ability of different formulations of aloevera in extending the shelf life of climacteric fruit.

Vitamin C content

The findings revealed a significant change in the Vitamin C content of the mangoes during storage and ripening for various postharvest treatment especially at the 3rd day, but, at the 9th day, the differences were not significant. Vitamin C content of mango is maximum in early stages of growth and decrease during ripening[17] and the amount of loss vary by species. Fluctuating amount of vitamin C at different maturity stages may be due to physical damage during harvesting and transportation because this component is used up by the fruit for combating external stresses.[19]

Conclusion

Mangoes hold significant economic importance in Nepal, with high consumer demand. The shelf life of mangoes is influenced by factors such as physiological weight loss, ripening, and susceptibility to fungal diseases, which reduce quality and marketability of fruits, leading to post-harvest losses. Traditionally, chemical treatments have been used to address these issues, but concerns about their effects on human health, environment and consumer preference for chemical-free products have prompted interest in alternative, eco-friendly and healthy solutions. Plant-based treatments, such as extracts from neem, garlic, ginger, onion, and aloe vera, have been identified as effective alternatives to delay ripening, control fungal growth, and preserve fruit quality. We also conducted experiment on above mentioned botanical extracts and according to the findings of this study, aloe vera extract stands out as a promising natural solution for extending the shelf life of mangoes. Its ability to reduce weight loss, enhance sweetness and flavor, and preserve vitamin C content positions it as an effective botanical for both improving the quality of mangoes and reducing post-harvest losses. By adopting such organic treatments, farmers and distributors in Nepal can better meet market demands, while also contributing to more sustainable agricultural practices

Citation: Neupane R, Poudel P, Karki PJ, et al. Effect of different organic treatment on the shelf life of Mango (*Mangifera indica* cv. Langra). *Horticult Int J.* 2024;8(4):95–100. DOI: 10.15406/hij.2024.08.00310

Acknowledgments

I deliver my deep sense of admire and honest gratitude to my advisor, Miss Pratima Poudel for her invaluable guidance, continuous support, precious recommendation, notion and encouragement throughout the period and education of my research. I am very grateful to HICAST and their authorities, I additionally wish to specific my honest thanks to Mr. Chakra Devkota for continuous support and encouragement offering the research idea and scientific writing to accomplish this study.

I am deeply grateful to my parents for their never-ending prayers, love, sacrifice, inspiration support, appreciation, and encouragement which have always given me courage in every step of my life.

Conflicts of Interest

Not any Conflicts of interest.

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