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RESEARCH ARTICLE

Effect of Aloe gel and cactus mucilage coating on chemical quality and sensory attributes of mango (*Mangifera indica* L.)

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ABSTRACT

Mango (*Mangifera indica* L.) is among major fruit crops grown in eastern Ethiopia. However, the postharvest handling problem contributes to huge postharvest loss of fruits. This experiment was conducted to study the effect of coating with Aloe gel and cactus mucilage on sensory and chemical quality of mango fruit. The experiment was laid out in completely randomized design (CRD) with three replications. The results revealed the significant effect of coating with aloe gel and cactus mucilage on most parameters considered. The interaction of aloe gel coating and storage period significantly influenced TSS, TA and sugar to acid ratio, while the interaction of cactus mucilage and storage period had significant effect only on TSS of mango juice. The aloe gel had significant effect on all sensory attributes while cactus only on color, appearance and over all acceptances. Generally, coating of mango fruits with aloe gel and cactus mucilage at 50 and 75% concentration level retard quality deterioration and keep good appearance. Therefore, coating of mango fruits with these extracts in combination and alone at higher concentrations could be used as alternative postharvest loss management of mango fruit. However, work requires replication in terms of cultivars, harvesting stage and different types of coatings.

Keywords: Aloe gel, cactus mucilage, coating, chemical quality, postharvest

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INTRODUCTION

Mango (*Mangifera indica* L) is an ever green fruit crop native to Southern Asia, especially Eastern India, Burma and the Andaman Islands. It belongs to the family anacardiaceae that is grown in more than 85 countries of the world with total area coverage and annual production of 3.69 million hectares and 35 million tons, respectively (Takele, 2014). Currently it is one of the most widely cultivated and traded tropical fruit crops in the world and in Ethiopia.

The attractive appearance and very pleasant taste of selected cultivars of mango make it to be the most important fruit of the tropics. It is one of the most delicious fruits and has been touted as 'king of all fruits'. There is a great diversity of mango fruit types, which permits considerable manipulation for various purposes and markets. Products such as juice, chutney, pickles, jam/jelly, fresh fruit, canned and dried fruit can be developed from mango fruit. Therefore, these given multiple products are a potential source of foreign exchange for a developing country and a source of employment for a considerable seasonal labor force (Griesbach, 2003).

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In addition to income opportunities, the mango has benefit of combating nutritional disorders. The mango compares favorably in food value with both temperate and tropical fruits. The fruit contains almost all the known vitamins and many essential minerals. Therefore, it can provide a large proportion of the daily human requirements of essential minerals and vitamins (Griesbach, 2003).

In Ethiopia, mango is produced mainly in Oromia, South Nation and Nationalities People Region (SNNPR), Benishangul Gumuz, Amhara, Harari and Gambela regions (Yigzaw et al., 2014). Mango produce in Assosa and Harar contributes to the highest market share in Ethiopia, which accounts for 28 and 23% respectively (Takele, 2014). Ethiopia has a comparative advantage in a number of horticultural commodities due to its favorable climate, cheap labor, and proximity to potential export markets. This opportunity is an input for the increment of its production from time to time. However, the export share of mango in Ethiopia is very small mainly due to low productivity and postharvest loss (Alemayehu et al., 2014). Short shelf life of mango produce, price competition between actors, price fluctuation (due to seasonality of mango production), disease, as well as lack of market information are the major constraints of mango production and marketing as reported by (Birara and Berihanu, 2017). The eastern part of Ethiopia such as Dire Dawa Administration, Fedis, Haramaya, Kombolcha, Kersa, Meta, Kurfa Chelle, Grawa, Jarso and Gemechis are major horticultural crops producer. However, postharvest loss and quality deterioration of horticultural crops in these areas is high during harvesting, marketing, transporting and storage. The highest postharvest loss is 45.32% for tomato followed by mango (43.53%). Among postharvest losses of mango, handling and storage shares about 19% of total loss (Mohammed and Afework, 2016).

The study commissioned by the Food and Agriculture Organization of the United Nations (FAO, 2011) also reported that one-third of global food produced for human consumption is lost or wasted throughout the food supply chain. Food losses occur at the production and postharvest stages shares about 65 per cent of the total losses. This implies the increment in production alone does not assure food security but it should be in combination with the management of postharvest loss.

Population of Ethiopia is increasing from time to time in which the demand for food and land to construct shelter is also increases alongside. The increment of the demand for food and land, results in reduction of the land allocation for farming because of land for shelter construction shares some parts of previous farmland. Therefore, searching for new technologies that enables to maximize the utilization and production through efficient postharvest handling of vegetable and fruit crops in reducing postharvest loss is very important. Reduction of postharvest losses and extending shelf life of the produce helps to increase food availability and diversity. The achievement of this issue contributes for the economic growth and assurance of food security by delivering sufficient quantity of food.

Postharvest technologies have great role in horticultural industries that helps to meet the global demands of local and large-scale production and intercontinental distribution of fresh produce that have high nutritional and sensory quality. Harvested products especially horticultural crops are metabolically active, undergoing ripening and senescence processes that must be controlled to prolong postharvest quality. Inadequate management of these processes can result in major losses in nutritional and quality attributes, outbreaks of food borne pathogens, and financial loss for all players along the supply chain from growers to consumers. Optimal postharvest treatments for fresh produce seek to slow down physiological processes of senescence and maturation, reduce or inhibit development of physiological disorders and minimize the risk of microbial growth and contamination (Mahajan et al., 2014).

To overcome the postharvest losses of perishable horticultural produces, treat produce with chemical fungicides and synthetic wax is common (Abbasi et al., 2011). However, using such products frequently causes problems associated with human health and environmental phenomena (Alemayehu et al., 2014). Therefore, researchers are searching to find other alternatives of natural organic materials and methods which possess both coating and antimicrobial properties together.

Newer technologies are emerging from time to time including postharvest technologies based on ethylene oxidation, inhibitors of ethylene action and modulators of ripening. Research on these technologies is continuing on a range of fresh fruits and vegetables including climacteric and non-climacteric types. There are wide ranges of physical and chemical treatments for fresh harvested fruits and vegetables to maintain and extend their shelf life. Specific treatments may only be applicable to certain types of product and spoilage conditions. Postharvest treatments, such as Controlled atmosphere storage (CAS) and Modified atmosphere storage (MAP) in combination with appropriate temperature control are the basis for maintaining physical, nutritional and sensory attributes. These can be supplemented by chlorine, SO_2, irradiation, hot water, hot air, antimicrobial agents and edible coatings as appropriate for the specific product (Mahajan et al, 2014).

Oluwaseun et al. (2014) also reported that O*puntia ficusindica* coating material is used for maintaining quality of mango fruits because of reducing postharvest losses. According to Abbasi et al. (2011), waxing and chemical treatments are the two remarkable mechanisms to reduce the postharvest loss to lower level. However, they are not affordable in price and not easily accessible to farmers. In addition to this, synthetic chemicals may have health related problems. Therefore, searching for local materials that can easily accessible by farmers and originated organically is more important in aspect of economic and health point of view. Coating fruits with plant extract provides advantages for farmers because of the easy availability and low cost. Suleyman et al*. (*2015) reported that in addition to prevents the defects in lipid metabolism and weight loss, the film developed from *Aloe debra* is serving as packaging film. Cactus pear (*Opuntia ficus indica*) mucilage extract with glycerol is greater in effectiveness than mucilage extract alone in extending the shelf life of papaya fruits (Oluwaseun, 2014). Therefore, it is reasonable to hypothesize that coating mango fruit with aloe (*Aloe debrana)* gel and cactus pear (*Opuntia ficus indica*) mucilage may have effect in reducing postharvest loss of the fruit. This study was initiated with the objectives to study the effect of *Aloe debrana* gel coating, *Opuntia ficus indica* mucilage coating and their combination on postharvest chemical quality and sensory attributes of mango.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Haramaya University in Horticulture Postgraduate Research laboratory during the year 2016. Haramaya University is located at 20 km Northwest of Harar town, altitude of about 1980 M.a.s.l., 9°41''N latitude and 42°03''E longitude. The site has a bimodal rainfall distribution pattern, which is representative of a sub-humid and mid-altitude agro-climatic zone. The short rainy season extends from April to July and the long rainy season extends from June to October. The area has an average annual rainfall of 790 mm, the minimum and maximum temperatures is 3.8 and 25^{0}C, respectively.

Mango harvesting and preparation for experiment

Green mature fruits of hula mango ecotype were harvested from farmers' orchard of Eastern Hararghe Zone, Harari region. Harvesting was carried out manually with care to minimize mechanical injury. The harvested fruits were transported to laboratory. Fruits were then sorted to exclude inferior ones which is followed by bulking and washing. Washing was carried out with tap water to remove soil particles and microbial populations from the surface. It was finalized by rinsing fruits with distilled water. After rinsing, fruits were allowed to air dry, which was followed by subdividing into sixteen categories in preparation for dipping treatments. Seventy five sample fruits for each treatment were then dipped in the prepared solution according to all possible combinations for twenty-five minutes. Plastic containers were used for dipping fruits. They were washed and rinsed with distilled water prior to use for the dipping purpose. Then coated fruits were placed on table as per treatments structure in random fashion with three replications. Sample fruits were washed before peeling at every test interval.

Coating treatment

Aloe debrana was collected from North Shoa zone of Oromia region. Cactus pear (*Opuntia ficus indica*) was collected from Haramaya University main campus.

Cactus mucilage: Cactus pear cladodes were scraped, pressed and sieved to separate pure mucilage from slurry. The extracted and sieved mucilage was then pasteurized at 70°C for 45 minutes. The concentration of cactus mucilage namely 25%, 50% and 75% was made by distilled water. The preparation of the solution was finalized by homogenizing cactus mucilage with the distilled water by using blender.

Aloe gel: Aloe gel was obtained from fresh aloe leaves (*Aloe debrana*). The matrix was separated from the outer cortex of the leaves. Then it was pressed and sieved to get pure gel. The gel matrix was pasteurized at 70ºC for 45 minutes and then similar procedure to that of cactus solution preparation, fruit dipping and placement was also applied for aloe.

Preparation of aloe gel and cactus mucilage combinations: The aloe gel and cactus mucilage solutions were mixed according to all possible combination levels. The solutions of cactus and aloe were homogenized with each other using blender.

Sensory evaluation

Samples of fifteen mango fruits were randomly chosen from each treatment for sensory evaluation at edible ripe stage. Fruits were washed and the pulp was cut in to slices for test. Panelists consisted of sixteen members judged and determined the mango fruits for the following sensory attributes: organoleptic quality, which determined by using olfactory sense and reflected by the taste and smell (aroma) of sliced fruit pulp. The panelists rinsed their mouth with water at each test interval between the treatments. The assessment was carried out by using hedonic scale of 1-9 (1- dislike extremely, 2- dislike very much,3-dislike moderetly,4- dislike,5- neither like nor dislike ,6-like, 7-like moderately, 8like very much, 9- like extremely).The color and appearance were judged by eyesight observation (Srivastra and Kumar, 2007).

pH measurement

Fruits were randomly selected from each treatment, washed and peeled. The juice was extracted from peeled mango fruits using juice extractor. The pH of mango juice was measured using pH meter. The sensor part of the device was washed with distilled water and dried as well with tissue paper for each test interval between the samples.

Total soluble solids

The degree brix of mango juice extracted was measured using method described by Mazumdar and Majumder (2003) using hand refractometer (model ATAGO ATC-1E). The prism of refractometer was washed with distilled water and blotted out with tissue paper before use. This was done for each test interval between samples. The device was standardized against distilled water in which TSS reading is 0 °brix. The total soluble solids (TSS) of mango juice were determined by dropping mango juice on prism of hand refractometer that has capacity to read in the range between 0-32°brix. Then the reading was obtained by pointed out the device towards light.

Titratable acidity

Ten gram of extracted mango juice was taken in to 100ml beaker and then it was homogenized with distilled water. The homogenized materials was then filtered by centrifuge and transferred to a 100 ml volumetric flask and the volume was made up to the mark with distilled water. Ten ml of solution was taken in to conical flask. Three drops of phenolphthalein indicator was added and the conical flask was shaken vigorously. The concentration of 0.1N NaOH solution allowed to drop in to flask contains juice from a burette until a permanent pink color appeared.

TA was calculated from the following formula as described by Islam et al. 2013. The titratable acidity expressed as percent citric acid was calculated as follow:

$$TA\% = ((Titre \times V1 \times N \times E)/(W \times V2 \times 1000)) \times 100$$

Where, T is titre, V1 is volume made up, N is normality of NaOH, E is equivalent weight of acid, V2 is volume of the extract and W is weight of sample.

Sugar to acid ratio

Sugar to acid ratio was calculated from total soluble solid and titratable acidity by using the following formula:

$$S/R = TSS/TA \qquad \text{Where } S/A = \text{Sugar to acid ratio}$$

Data Analysis

The treatments consisted of factorial combination of aloe and cactus each at four levels (0%, 25%, 50% and 75%) and storage period of four levels (4, 8, 12 and 16). The experiment was set in a completely randomized design (CRD) with three replications. All collected data were subjected to analysis of variance using Gen stat 15th edition statistical software at LSD (5%).

RESULTS AND DISCUSSION

Chemical Properties of Fruits

The interaction of aloe gel coating and storage period significantly influenced ($P<0.001$) TSS, TA and ($P<0.01$) sugar to acid ratio. Interaction of cactus and storage period also significantly ($P<0.01$) influenced the TSS of mango juice. Aloe gel, cactus mucilage and storage period highly significantly ($P<0.001$) influenced all chemical parameters considered except TSS by aloe gel and cactus mucilage. The interaction of aloe gel, cactus mucilage and storage period as well as aloe gel and cactus mucilage did not show significant effect on chemical parameters (TSS, TA, sugar to acid ratio and pH). The interaction of Cactus and storage period also did not show significant effect on TA, sugar to acid ratio and pH (Appendix Table 3).

The results from analysis of variance showed that the three main factors had significant effect on chemical parameters of fruits except aloe gel and cactus mucilage on TSS of fruit juice. While the two possible two factor interaction significantly influenced only one parameter and one possible two factors interactions had significant influence all four chemical parameters. However, three factors interaction did not show significant effect on all chemical properties of the fruit assessed. Therefore, the results suggested the importance of considering the possible two factors interactions since the all-important fruit chemical parameters (TSS, TA and sugar to acid ratio) were significantly influenced. The result also suggested considering main factor for interaction non-significant parameter (pH).

Interaction effect of storage period and aloe gel on chemical properties of fruits

Interaction of aloe gel and storage period significantly affected three chemical parameters ($P<0.001$) TSS, TA and ($P<0.01$) sugar to acid ratio. Sugar to acid ratio of mango juice showed increasing trend regardless of treatments as storage period increases from 4 to 16 days, while, TA and TSS of fruits showed decreasing trend, fluctuating trend of increasing and decreasing respectively. However, coating fruits with ale gel acted against the trend starting from 4th day of storage. Application of aloe gel at concentration level of 25, 50 and 75% significantly affected TSS on 8th, TA on 8th, sugar to acid ratio on 8th, 12th and 16th day of storage as compared to results obtained from zero level of aloe. Its application at concentration level of 50 and 75% also significantly affected TSS and TA on 4th, 12th and 16th day of storage as compared to results obtained from zero level of aloe (Table 1).

The highest TSS was obtained from zero level of aloe on 4th and 8th day of storage. While, the highest levels of coating provided low TSS value. On 12th and 16th day of storage, the highest TSS was obtained from application of aloe gel at concentration level of 75%. The reduction of TSS due to increment of aloe gel concentration from 25 to 75% was ranged from 0.17 to 0.92°brix on 4th and 0.75 to 1.41°brix on 8th day of storage as compared to results obtained from zero level of aloe. While, maintained high TSS due to increment of aloe gel concentration from 25 to 75% was ranged from 0.17 to 1.17°brix on 12th and 0.17 to 1.25°brix on 16th day of storage.

Coating fruits with aloe gel at concentration level of 50 and 75% significantly maintained high TA value of mango juice as compared to zero level of aloe staring from 4th day of storage. Its application at concentration level of 25% also significantly maintained high TA value as compared to zero level of aloe on 8th day of storage. At the end of storage days (16th) the highest percentage acidity (0.41) was exhibited by application of 75% aloe gel. While zero level of aloe provided titratable acidity percentage of 0.29 at the end of storage day. Maintenance of high TA value due to increment of aloe gel concentration from 25 to 75% was ranged from 0.06 to 0.15% on 4th day of storage, 0.13 to 0.39% on 8th, 0.03 to 0.13 on 12th and 0.06 to 0.12% on 16th day of storage.

Coating fruits with aloe gel significantly maintained low sugar to acid ratio after 4th day of storage as compared to results obtained from zero level of aloe. At the end of storage period, the lowest sugar to acid ratio (37.1) was exhibited by coating mango fruits with aloe gel at 75% concentration level. While, zero level of aloe provided value of 48.03 sugar to acid ratio. The reduction of sugar to acid ratio due to increment of aloe gel concentration from 25 to 75% was ranged from 7.09 to 14.48 on 8th day of storage, 2.6 to 6.21on 12th and 6.29 to 10.93 on 16th day of storage as compared to results obtained from zero level of aloe(Table 1).

Table 1. Interaction Effect of Storage Period and Aloe Gel on Chemical Properties of Fruits

Coating concentration (%)	Storage Period(days)	Chemical parameters		
Aloe (%)	days	TSS(ºBrix)	TA (%)	Sugar to acid ratio
0	4	13.67f	0.82c	16.77h
25	4	13.5fg	0.88bc	15.69h
50	4	13.08gh	0.97a	13.82h
75	4	12.75h	0.97a	13.38h
0	8	15.08ab	0.52efg	29.71ef
25	8	14.33cd	0.65d	22.62g
50	8	14.00def	0.89bc	15.86h
75	8	13.67f	0.91ab	15.23h
0	12	14.25de	0.45gh	33.29de
25	12	14.42cd	0.48fgh	30.69ef
50	12	14.83bc	0.53ef	28.23f
75	12	15.42a	0.58de	27.08f
0	16	13.58fg	0.29j	48.03a
25	16	13.75ef	0.35ij	41.74b
50	16	14.33cd	0.37i	39.55bc
75	16	14.83bc	0.41hi	37.10cd
LSD(0.05)		0.54	0.075	4.02
CV(%)		4.8	14.7	18.6
Initial value=		11.89	1.19	9.91

Means with common letter(s) in column in each interaction effect have non-significant difference at P<0.05, LSD (0.05) = least significant difference at P<0.05 and CV (%) = coefficient of variation in percent, TSS= total soluble solid in brix, TA=titratable acidity in percent

The effect of coating on chemical properties of mango fruit has been reported by (Goal and Rao, 2013, Aguiar et al., 2011). The effect of aloe gel and cactus mucilage coating might be due to retardation of climatic rise of the fruit that cause less conversion of acid to sugar as well as due to less utilization of acid for metabolic activity. The retardation of climatic rise also might be due restriction of respiratory substrate and retardation of enzyme activity. This suggestion was supported by Goal and Rao (2013) who reported that titratable acidity of the coated mango fruits decreases with the storage time but to a lesser extent than uncoated fruit. While the TSS increases with storage time and tends to decline slightly at respiratory peak stage. Author also reported that the level of TA declining during storage is due to the metabolic changes and use of organic acid in the respiratory process. Aguiar et al. (2011) studied the effect of a galactomannan coating on postharvest physicochemical quality parameters of mango.

They found that coating delays the catalase activity peak which is coincident with the lowest lipid per oxidation. This results in low TSS and maintenance of TA to lower extent. Chaiprasart and Hansawasdi (2009) also reported that the TSS to TA ratio of uncoated mango fruits gradually increase during storage period and its highest peak value will be attained before coated fruit. Oluwaseun et al. (2014) also reported that the increases of pH with advancement of storage period. They also reported coating of papaya fruit with cactus mucilage is found effective to reduce the pH of fruit. The effect of aloe gel and cactus mucilage coating might be due to deactivation of enzymes responsible for pH increase. This suggestion was supported by Goal and Rao (2013) who explained that pH is significantly lower in the zein and gelatin coated mango fruits as compare with those of uncoated fruits. The authors also reported that activity of enzymes in coated fruit is low which leads to slow ripening.

In general, the increase of TSS, pH and sugar to acid ratio might be due to increase of oxygen that causes rise in respiration. The increase of respiration results in conversation of Starch to sugar which also cause reduction of fruit acidity as the result of fruit ripens. The length of time it requires to ripe depends on respiration rate. The rate of respiration can be measured by the amount of O_2 consumed and CO_2produced (Devanesan, 2012). Therefore, the highest O_2 consumption implies moreCO_2 release as well as rapidly reach respiratory peak. The aloe gel and cactus mucilage coating may acted against substrates of respiration.

Interaction effect of storage period and cactus mucilage on total soluble solids of fruits

Interaction of cactus mucilage and storage period significantly affected TSS of mango juice. Application of cactus at 50 and 75% on 8th day of storage provided significantly low TSS as compared to zero level of aloe. But not significant difference observed between cactus coated and non-cactus coated fruits on 4th and 12th day of storage. Coating fruits with cactus mucilage at concentration level of 75% on 16 day of storage also provided significantly highest TSS as compared to zero level of cactus. Significant reduction of TSS due to application of cactus mucilage was ranged from 0.33 to 0.92°brix on 8th and maintained 0.17 to 0.83°brix on 16th day of storage as compared to results obtained from zero level of cactus. But did not significantly varied on 4th and 12th day of storage. On the 8th day of storage, fruits that did not receive cactus recorded 14.75 °brix while, application of cactus mucilage at concentration level of 75% provided total soluble solid of 13.83 °brix. On the other hand, at 12th day of storage cactus at 75% concentration recorded 14.75 °brix. However, the value of TSS was 14.58°brix for zero level of cactus on the same day of storage. At the end of storage period (16th day), the highest TSS (14.58°brix) was obtained from application of cactus at 75%, while, zero level of cactus provided TSS of 13.75°brix (Table 2).

Table 2. Interaction effect of storage period and cactus mucilage on total soluble

Coating concentration (%)		TSS(°Brix)			
	Sp(days)	4	8	12	16
Cactus %)					
0		13.42fgh	14.75ab	14.58abc	13.75efg
25		13.25gh	14.42abcd	14.75ab	13.92def
50		13.08h	14.08cde	14.83a	14.25bcde
75		13.25gh	13.83ef	14.75ab	14.58abc
LSD(0.05)		0.54			
CV(%)		4.8			

Initial value=11.89 °Brix

Means with common letter(s) in columns and rows in each interaction effect have non-significant difference at P<0.05. LSD (0.05) = least significant difference at P<0.05 and CV (%) = coefficient of variation in percent, SP (days)=storage period in days.

Table 3. Effect of aloe gel, cactus mucilage and storage period on pH of mango

Factor	Treatment	pH
Aloe (%)		
	0	5.26a
	25	5.11b
	50	4.93c
	75	4.90c
LSD(0.05)	0.11	
CV(%)	5.4	
Cactus (%)		
	0	5.18a
	25	5.12a
	50	4.96b
	75	4.94b
LSD(0.05)	0.11	
CV((%)	5.4	
Storage period(days)		
	4	4.55d
	8	4.73c
	12	5.35b
	16	5.58a
LSD(0.05)	0.11	
CV(%)	5.4	
Initial value		3.74

Means with same letter(s) in column have non-significant difference at P<0.05. LSD (0.05) = least significant difference at P<0.05 and CV (%) = coefficient of variation in percent, pH= potential of hydrogen, LSD (0.05) = Least significant difference at P<0.05

The interaction effect of coating and storage period on total soluble solids of mango has been reported by Krishna and Rao (2014). The effect of cactus mucilage coating might be due to retarding effect of respiration by limiting the diffusion of oxygen to fruit tissue that can be used as substrate for respiration. These results in retardation of ripening process, which also reduces the amount of sugar to be utilized for respiration. The initial increase in TSS might be due to conversion of starch to usable form of carbohydrate. The declining trend might be also due to utilization of sugar for respiration as a substrate. Krishna and Rao (2014) who confirmed that initially increase and finally decline trend of TSS supported this suggestion. The author also reported that initial increase of TSS is due to conversion of starch to sugars and the declining trend is due to utilization of the products for metabolic activity.

Effect of aloe gel, cactus mucilage and storage period on pH of mango

pH of mango showed significant increasing trend with the advancement of storage period. It was ranged from 4.55 to 5.58. However, coating fruits with aloe gel and cactus mucilage showed significant reduction of pH. The reduction of pH due to increment of aloe gel and cactus mucilage from 25 to 75% was ranged from 0.15 to 0.36 and 0.06 to 0.24 as compared to results obtained from zero level of aloe and cactus respectively.

The effect of coating on pH of mango juice has been reported by Goal and Rao (2013). The effect of aloe gel and cactus mucilage coating might be due to deactivation of enzymes responsible for pH increase. This suggestion was supported by Goal and Rao (2013) who explained that pH is significantly lower in the zein and gelatin coated mango fruits as compare with those of uncoated fruits. The author also reported that activity of enzymes in coated fruit is low which leads to slow ripening.

Sensory Attributes

Analysis of Variance

The interaction of the two coatings (aloe x cactus) did not show significant effect on sensory attributes. The results of this study showed that Coating of mango fruits with aloe gel and cactus mucilage had significant effect on sensory attributes with exception of cactus mucilage on taste and smell.

The results suggested the importance of considering two main factors for sensory attributes since the interaction effect was no significant on such parameters.

Effect of Aloe Gel and Cactus Mucilage on Sensory Attributes of Mango

Coating of mango fruit with aloe gel significantly affected all sensory parameters (taste, smell, color) and appearance and over all acceptability. The aloe gel coating of mango fruits at the concentration level of 75% showed significantly low score of taste. However, its application showed high score of taste and smell at concentration level of 25, 50% as well as high color score at 25%. Coating fruits with aloe gel at 50 and 75% did not show significant difference in affecting smell and color as well as overall capability at 75% concentration level as compared to results obtained from zero level of aloe. Application of aloe gel at concentration level of 25 and 50% was significantly accepted by panelists as compared to the rest levels including zero level of aloe. It was found that coating of fruits with aloe gel and cactus mucilage was more effective method to improve appearance than improving other sensory attributes (Table 4).

Table 4. Effect of aloe gel and cactus mucilage on sensory attributes of mango fruits

Aloe gel (%)	Taste	Smell	Color	Appearance	Overall acceptance
0	7.146a	7.204ab	7.328ab	7.009b	7.109b
25	7.237a	7.271a	7.5ooa	7.056b	7.267a
50	7.005ab	7.252a	7.198b	7.407a	7.268a
75	6.812b	7.062b	7.078b	7.343a	7.039b
LSD (0.05)	0.304	0.159	0.268	0.190	0.117
CV(%)	5.2	2.6	4.4	3.2	2.0
Cactus mucilage (%)					
0	7.274	7.159	7.354a	7.009b	7.179ab
25	7.078	7.319	7.474a	7.102b	7.244a
50	6.849	7.104	7.047b	7.352a	7.064b
75	7.000	7.206	7.229ab	7.361a	7.216a
LSD (0.05)	NS	NS	0.268	0.190	0.117
CV (%)	5.2	2.6	4.4	3.2	2.0

Means followed by same letter(s) in a column in each treatment are not significantly different at P<0.05, NS= non significant difference at p<0.05, LSD (0.05) = Least significant difference at P<0.05 and CV (%) = coefficient of variation in percent.

Coating of mango fruit with cactus mucilage significantly affected sensory parameters (P<0.01) color, over all acceptability and (P<0.001) appearance). However, cactus mucilage did not significantly influence taste and smell of the fruit. Coating fruit with cactus mucilage at concentration level of 50 and 75% significantly maintained good appearance of fruit with score of

7.352 and 7.361 respectively as compared to zero level of aloe with score of 7.009. The cactus mucilage coating of mango fruits at the concentration level of 50% also showed low score of taste than uncoated fruit. However, it showed high score of smell and color at concentration level of 25%. Panelists preferred fruits coated with cactus mucilage at concentration level of 25% as compared to 75% cactus mucilage concentration, however, there was no significant difference observed in preference between cactus coated and non-coated fruits.

Application of aloe gel at 50% concentration level scored highest value for over all acceptance, while cactus scored the lowest at the same level of concentration. The difference for panelists acceptance level between two coatings might be due to cactus scored low value for taste and smell as compared to aloe.

The effect of coating on sensory attributes has been reported by Baldwin et al*.* (1999). The effect of aloe and cactus mucilage coating that result in lowest score of taste and smell might be due to oxidative stress by excess coating. The high score of taste and smell also might be due to retention of phenol compounds. This suggestion was supported by Vargas et al. (2008) finding that excess restriction of gas exchange through skin causes anaerobic and further development of off flavor and odor. Furthermore, Baldwin et al. (1999) studied the beneficial effects of fruit coatings with cellulose-based polysaccharides and found that the improvement of appearance, attractive natural-looking sheen, waxy feels and smooth but less flavor.

CONCLUSION

The interaction of aloe gel coating and storage period significantly influenced total soluble solids (TSS), titratable acidity (TA) and sugar to acid ratio while the interaction of cactus mucilage and storage period had significant effect only on total soluble solids of mango juice. Fruits coated with aloe gel at 50 and 75% concentration level had significantly high total soluble solids and titratable acidity at the end of storage period (16^{th}) as compared to results obtained from zero level of aloe. However, significantly lower sugar to acid ratio was obtained at the same concentration level of aloe. Fruits coated with cactus mucilage at 75% concentration level also had significantly highest total soluble solids at 16 days of storage. The cumulative pH value at the end of storage day was also high as compared to values of preceding storage days.

The sensory attributes of fruits were more influenced by coating of fruits with aloe gel than coating of fruits with cactus mucilage. The sensory attributes of fruits were not significantly influenced by any of the possible interactions of factors. The aloe gel coating of fruits significantly affected all sensory attributes. However, cactus only significantly affected color, appearance and over all acceptance. The highest mean values were obtained for Taste, smell, color, over all acceptance from fruits coated with aloe gel at 25%, but cactus provided highest mean value only for smell, color and over all acceptance at 25% concentration level. Aloe gel at 50% concentration level and cactus at 75% also provide the highest mean value for appearance and over all acceptances.

It can be concluded that aloe gel and cactus mucilage application at 50 and 75% both in combination and alone had a tendency to retard quality deterioration and keep good appearance. Considering the current study results, it is recommended to coat mango fruits with aloe gel and cactus mucilage at higher concentrations (50 and 75%) both alone and in combination. However, it is hardly possible to make conclusive recommendation with the results of one experiment conducted once on one ecotype. Therefore, it is suggested to conduct experiments by including more ecotypes or varieties having contrasting characters of fruits, including fruits harvested at different maturity stages and coating hot water treated fruits.

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