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Effects of Sunflower Wax Coating on Physicochemical Changes of Mangifera Indica L. in Storage Life

Rizwana K. Soomro[1], S. T. H. Sherazi*[1] and S. A. Sheikh[2]

[1]*National Center of Excellence in Analytical Chemistry University of Sindh, Jamshoro -76080, Pakistan*

[2]*Institute of Food Sciences and Technology, Sindh Agriculture University Tandojam, Pakistan*

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Abstract

Mango (Mangifera indica L.) fruit has a relatively short storage life due to perishable nature. In order to increases the storage life of 'langra' mangoes, fruits were coated with sunflower wax. Mangoes were stored at room and refrigerated temperature. Sunflower wax coating protects the mangoes in greater proportion to change their color, weight loss, moisture loss, pH and total soluble solids content. The sensorial panel also favors the grander role of sunflower wax coating. Application of sunflower wax coatings had no effect on vitamin 'C' content of mangoes variety and could increases mango storage time around 30 days under regular storage conditions. Sunflower wax coating also inhibited the growth of micro-organisms. The data reveal that by applying a sunflower wax coating effectively prolongs the quality which attributes and extends the shelf life of mango.

***Keywords*:** Sunflower wax; Coating, Mangoes; Physicochemical properties; Microbial activity.

Introduction

Mango (Mangifera indica L.) is one of the most popular fruit all over the world and famous as king of fruits as it has attractive color, delicious taste and excellent nutritional properties with a high commercial value on the international fruit market [1]. Pakistan is at 7th position among main mango producing countries with production of 77,468 MT and export accounts for 9.4% of total world production valued at $ 32.35 million [2] is the second major fruit crop in Pakistan. More than 200 varieties contributing major share in the economy of the country [3]. Naturally, the mangoes are perishable and ripe rapidly after their harvesting therefore, due to improper handling, packaging, storage and poor post-harvest managements of mango, producers and traders in Pakistan face 20-30% losses of this perishable commodity [4] that corresponds to 320.7 thousand tons with a value of Rs 3.0 billion [5]. However, the scientists are working over the prolong shelf life of this fruit while keeping its quality and flavor up to the required level.

Wax coatings have been used since the 1930s to protect and extend shelf life of various fruits and vegetables [6]. Edible films and waxes have been applied for decades on fresh fruits product to create a barrier on the surface of the fruits to suppress respiration, control moisture loss, add gloss, and more recently, to provide a delivery mechanism for additional functional components [7, 8]. The sunflower wax is the valuable by-products of edible oil and consists of a complex mixture of various compounds such as hydrocarbons, esters, fatty alcohols, ketones, mono-, di-, tri-acylglycerols and sterol esters [9, 10]. These vegetable oil waxes have no any noxious upshots on human health upon consumption. According to FDA, they are food grading vegetable oil waxes. By

*Corresponding Author Email: tufail.sherazi@yahoo.com

keeping in view the importance of the mango fruit and its short shelf life, present research has been designed to observe the effect of sunflower wax coating on mango for the enhancement of shelf life.

Materials and Methods

The mangoes (langra) of ripe good quality and free from any apparent damage were purchased from local market of Hyderabad Pakistan. Sunflower wax was collected from local oil industry situated at Karachi Pakistan. The fruit was washed, cleaned and dried with muslin cloth. Mango fruit was subjected to sunflower wax coating.

Wax application

Dipping or cold wax method

Mangoes were waxed by using Dipping or cold wax method, 250 g of sunflower wax was melted in a stainless steel container on a hot plate at 70 ^{o}C. When the wax had melted completely, the container was left on the hot plate at 50 ^{o}C prior to wax treatment on the mango. Each mango was immersed for 3 s into the molten sunflower wax, each fruit was coated with 0.5 g of sunflower wax (weight of each mango was calculated on analytical balance before and after waxing), and samples were divided into three sets, each set contained three replicates. One set was kept at room temperature (25 ± 2 °C) and coded as MWT (mangoes with sunflower wax coating and kept at room temperature). The second sample was kept at refrigerated temperature (4 ± 2 °C) with code MWR (mangoes with sunflower wax coating and kept at refrigerated temperature whereas, third sample control without wax coatings and kept at room as coded as MT (mangoes without sunflower wax coating and kept at room temperature) and fourth set was kept at refrigerated temperature and coded MR (mangoes without sunflower wax coating and kept at refrigerated temperature) respectively. All of them were stored for the period of 30 days. The samples were taken at regular time interval of six days for physicochemical, sensory and microbial analysis.

Physicochemical evaluation of Mangoes fruit

Weight loss was evaluated by weighing 15 fruits per treatment before and after storage, and calculating the % of weight loss. The moisture % was determined according to the method of AOAC. 5 g sample was placed in a crucible and kept in an oven at 80 ^{o}C for 12-18 hours. Then crucible was removed and placed in desiccator and weight was recorded. Sample was placed again in an oven at 80 ^{o}C for another two hours. The moisture % was calculated according to the following formula.

$$\text{Mositure \%} = \frac{\text{Wt. of fresh sample} - \text{Wt. of dried}}{\text{Wt. of fresh sample}} \times 100$$

Total solids content was evaluated in a refractometer (ATAGO-RX). The pH values were recorded using a pH meter (Hanna model-211, Padova Italy). Each sample was analyzed with three replicates. Changes in outer looks were recorded by using digital photographic camera (13.6 Mpix Ciber Shot, Sony).

Sensory evaluation

The sensory evaluation of mangoes were made by the panel of 25 judges using hedonic 9 point scale on the basis of overall mango appearance methods reported by Larmond (1977).

Determination of ascorbic acid (Vitamin C)

Ascorbic acid contents in mangoes were measured by titration method [11]. 10 g of sample soaked in distilled water for 10 min and filtered it by Whatman filter paper # 4. The juice was extracted from mangoes by blender machine. The 10 ml sample was taken in 500 ml conical flask and 15 ml of 4% oxalic acid was added. The sample was titrated with 0.2% Dichlorophenol-indophenol (DCPIP). The results were calculated as per following formula and expressed as mg/g fresh/dry weight.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Vol. made up}}{\text{Vol. of filterate taken} \times \text{Wt. or Vol. of sample}} \times 100$$

Microbial activity

Spores of fungal strain (*Aspergillus flavus*) were inoculated on Potato Dextrose Agar (PDA). Petri dishes of PDA were incubated at 30 °C during 5 days and the produced spores were harvested with a sterile solution of 0.01% Tween 80 and counted in a Neubauer chamber. Harvested spores from the two fungal cultures (PDA plates) were inoculated in covered and uncovered mangoes. An inoculation level of 1×10^7 spores per each fruit was used. All fruits were put in polystyrene trays adapted with a special orifice with cotton cork, which permit the respiration process and avoid the humidity accumulation. Trays were incubated at 22.2-22.4 °C and 62-63% of relative humidity, during a period of 30 days. Changes in appearance were evaluated with the following scale: 0 =without damage, 1 = slight damage (<25%), 2= moderate damage (>25% and <50%), 3 = severe damage (>50% and <75%) and 4 = rotten fruit (75% - 100%). IDC = Σ (damage level) * (Number of fruits per level) / Total number of fruits.

Statistical analysis

For the first experimental step, a randomized experimental design with factorial fix 3×8 with six replicates was used. Three were the number of levels of factor 1 (kind of coating) and 8 was the number of levels factor 2 (storage time). For the microbiological assay, each treatment with 4 groups and 3 replicates were employed. Obtained data were statistically analyzed with an analysis of variance using the Minitab® 15.1.30.0 software. Mean of values were compared through a t-student test ($\alpha = 0.05$). For results of sensorial evaluation, data were analyzed using an E.B.Roessler table.

Results and Discussion

The effect of the sunflower wax coating on mangoes were studied during the period of 30 days storage both at refrigerated ($4 \pm 2\ ^oC$) and room temperature ($25 \pm 2\ ^oC$).

Table 1 represented the change in physical parameters of mangoes during the storage time. Weight loss is very important for fruits and the use of wax coating is an excellent tool to control the reduction in weight loss. Weight loss % during the 30 days of storage was given in (Table 1); the wax coating was effective in slowing down weight loss. In all mangoes, the weight loss was increased ($p < 0.05$) during the storage period. The fruits with sunflower wax coating and kept at refrigerated temperature showed the lowest weight loss, high % of weight loss was observed in MR (mangoes without wax coating kept at room temperature).

Table 1. **Physical parameters of langra mangoes during storage of 30 days**

Treatments	Weight loss %	Moisture %	Sensory quality
Initial (355 g)	0.00	94.01±4.9	9
Before treatment			
MWT	0.00	94.01±4.9	9
MWR	0.00	94.01±4.9	9
MT	0.00	94.01±4.9	9
MR	0.00	94.01±4.9	9
After 6 days storage			
MWT	1.42±0.0	92.65±4.8	8
MWR	0.80±0.00	93.11±4.1	8
MT	1.98±0.1	90.36±4.7	7
MR	1.78±0.1	91.76±4.8	8
After 12 days storage			
MWT	2.25±0.3	90.56±4.1	7
MWR	1.0±0.0	91.98±4.0	8
MT	2.69±0.4	87.23±4.2	6
MR	2.48±0.4	88.53±3.9	7
After 18 days storage			
MWT	2.81±0.3	88.23±3.8	6
MWR	1.43±0.1	89.14±3.7	7
MT	3.98±0.8	85.01±3.6	5
MR	2.99±0.6	86.74±3.9	6
After 24 days storage			
MWT	3.89±0.9	86.76±3.7	6
MWR	2.01±0.7	88.69±3.1	7
MT	4.87±1.3	82.35±4.2	5
MR	3.65±0.9	84.17±4.7	6
After 30 days storage			
MWT	4.1±1.8	83.19±4.9	6
MWR	2.53±0.8	87.28±3.7	7
MT	6.0±2.4	76.01±3.1	4
MR	5.03±2.1	79.80±3.0	5

Generally, the use of sunflower wax diminished the moisture loss in fruits, loss of moisture from the fruits causes the reduction of weight loss but edible films help to prevent the loss of water vapors form the surface of fruits [12]. These Waxes were the barrier around the fruit which avoids the loss of water vapor from the surface of fruits. From the results, it is evident that the moisture % of mangoes fruit with MWR and MWT was not effectively changed during the storage as compared to MT and MR (Table 1). After 30 days of storage, moisture losses % of the control mangoes were highest at room temperature and control mangoes at refrigerated temperature were 76.01 % and 79.80 % respectively.

Sensorial profile of this study clearly showed that the consumer was not able to detect visual or taste differences among treated and untreated fruits. By this reason, the application of sunflower wax is an excellent alternative to preserve mangoes fruits. Results of sensorial evaluation demonstrated that with the number of correct answers by the judges and comparing them with the corresponding table, there were not significant differences among all treatments (significance level of 1%) in both assays, for appearance and flavor. It means that sunflower wax did not modify the color and flavor of mangoes.

The apparent changes in fruits were significantly affected with the exchange of gases due to this modification of internal atmosphere of the fruit is effected, with high levels of carbon dioxide and low levels of oxygen, retarding the maturity process [13]. Appearance changes in fruits were evident at end of the storage period (30 days). Mangoes with sunflower wax coating presented the minor level of changes, while mangoes without coating were seriously aged.

Table 2 represents some chemical parameters of mangoes during storage time and records the effect of coating during storage. The pH values increased during the period of study for all treated samples (Table 2) However, MWR and MWT mangoes showed smallest change in pH as compared to MR and MT ($P < 0.05$).

Table 2. **Chemical parameters of langra mangoes during storage of 30 days**

Treatments	pH[a]	TSS (brix°)[b]	Vitamin C content (mg/100g)
Initial	5.26±0.2	14.8±0.5	245.6±3.7
Before treatment			
MWT	5.26±0.2	14.80±0.5	245.6±3.7
MWR	5.26±0.2	14.80±0.5	245.6±3.7
MT	5.26±0.2	14.80±0.5	245.6±3.7
MR	5.26±0.2	14.80±0.5	245.6±3.7
After 6 days storage			
MWT	5.31±0.1	15.18±0.6	245.6±3.7
MWR	5.26±0.2	14.98±0.5	245.6±3.7
MT	5.35±0.3	15.42±0.7	250.3±3.9
MR	5.32±0.3	15.29±0.6	249.1±3.8
After 12 days storage			
MWT	5.33±0.3	17.3±0.8	246.1±3.9
MWR	5.27±0.2	15.2±0.4	245.9±3.7
MT	5.40±0.4	18.61±0.9	252.3±3.9
MR	5.36±0.3	17.83±0.6	251.9±3.3
After 18 days storage			
MWT	5.48±0.4	18.71±1.0	246.2±3.5
MWR	5.32±0.3	15.36±0.9	246.1±3.9
MT	5.68±0.5	18.98±1.3	254.4±4.1
MR	5.57±0.4	17.85±1.0	255.3±3.8
After 24 days storage			
MWT	5.75±0.4	18.3±1.2	246.4±3.7
MWR	5.40±0.3	16.2±0.9	246.1±3.9
MT	5.89±0.5	19.6±1.5	254.4±4.3
MR	5.80±0.4	17.8±1.3	255.3±4.1
After 30 days storage			
MWT	6.15±0.8	19.3±2.3	246.5±4.3
MWR	5.53±0.5	17.2±1.9	246.3±3.2
MT	6.40±0.9	21.6±2.7	254.7±4.7
MR	6.22±0.8	18.8±1.5	255.5±4.5

a= negative logarithm of hydrogen ion concentration
b= total soluble solids content

No significant changes in the total solid contents were observed during the storage period in all treatments. MWR treatment shows a slight increment but no significant in the total solid content of mangoes (Table 2).

No significant changes were observed in ascorbic acid contents of mangoes during storage periods of MWR and MWT (Table 2). Only slight variation occurred in coated sample, but uncoated mangoes showed reasonable changes in ascorbic

acid contents this is possibly due to the decomposition of ascorbic acid.

The fungal growth is due to moisture loss, release of ions and other cell components, which provide a rich medium for the development of the microorganisms [14] and growth of fungus is prevented with the application of edible coating. (Fig. 1) represents the percent damage of mangoes caused by fugal species. When sunflower wax coating was applied to mangoes for evaluation of their efficiency against microorganisms, remarkable results were observed as the use of sunflower wax completely inhibited the fungal growth of the *Aspergillus flavus.* Mangoes without coating were totally invaded by the growth of the fungal strains. From the aforementioned results it is concluded that sunflower wax could be used to prolong the shelf life and quality of mangoes providing an important antifungal activity.

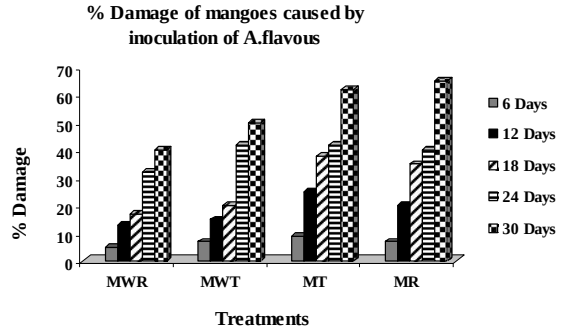

Figure 1. **Microbial activity of sunflower wax coating on mangoes from 6 - 30 days.**

Conclusion

Safety of perishable food like mangoes are maintained by using different wax, so present study has been designed to increases the shelf life of mango fruit by using sunflower wax coating on langra variety of mango. Sunflower wax coating improves appearance, color, flavor, nutritive value, texture of mangoes. Sunflower wax also protects mangoes from microorganisms since it is an excellent antifungal barrier against all microorganisms.

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