Original Research Article

Effect of different edible coatings on physical and physiological characters of acid lime (*Citrus aurantiifolia* Swingle) cv. Sai Sharbati

Abstract

An experiment was conducted to evaluate the effect of different edible coatings on physical and physiological characters of acid lime (*Citrus aurantiifolia* Swingle) cv. Sai Sharbati from October, 2023 to November, 2023 under Completely Randomized Block Design (CRBD) with three replications and nine treatments at ambient room temperature. The parameters recorded were fruit length (mm), fruit diameter (mm), fruit firmness (kg/cm^2), physiological loss in weight (%) and shelf life (days) in every 3 days interval till 21st day. The maximum fruit length (36.16), fruit diameter (34.36) and fruit firmness were observed in fruits treated with coconut oil 100%. Minimum percentage of physiological loss in weight (5.36%) was found in the fruits treated with coconut oil 100%. Whereas, shelf life was found maximum (21 days) in fruits treated with coconut oil 100 % while, it was only 10 days in control fruits. Coconut oil coating increases the shelf life of acid lime by reducing physiological loss in weight and maintaining the fruit firmness.

Key words- *Acid lime, edible coatings, postharvest treatments, shelf life*

Introduction

India is the largest producer of acid lime in the world (Kumari and Dhingra, 2024). In India, acid lime occupying more than 10% of the total area under citrus cultivation. In India, acid lime is grown on an area of 313 thousand hectares with total production of 3776 thousand MT with productivity of 12.06 MT/ha. In Maharashtra, acid lime is grown on an area of 29.13 thousands hectares with total production of 261.79 thousands MT with productivity of 8.98 MT/ha.

Acid lime is a citrus fruit belonging to the Rutaceae family. It's botanically called as *Citrus aurantifolia* Swingle (Patil *et al.*, 2023). The high acceptability is due to their attractive colour and distinctive flavour, and the fact that they are a rich source of Vitamin 'C' and also contain Vitamin B, pectin, organic acids, minerals and other nutritive substances, required for human health (Bisen and Pandey 2008). Acid lime is non-climacteric fruit, with storage life of 6 to 8 days at ambient condition.

The postharvest losses in fruits are high in tropical countries like India, which ranges between 20-30% before they reach the consumer. A large quantity of fruits goes waste due to lack of proper postharvest handling due to which most of the horticultural produce goes waste. Therefore, it is very important to minimize such postharvest losses and to increase the quality and shelf life of fruits to meet requirement of ever, increasing population (Kumari and Dhingra, 2024).

During the peak season, an oversupply of lime fruits leads to the market glut, resulting in unfavourable prices for producers, often leading to low prices

(referred to as "throwaway prices"). Although the fruit has a fairly good shelf life, yet enhancement of its shelf life may prove beneficial for its utilization during the off-season when prices are very high spoilage. Chitosan, bee wax, coconut oil and aloe vera gel can improve the shelf life of acid lime beacause, they can reduce respiration, preserve firmness, prevents moisture loss, protects the fruits from microbial, reduces weight loss and retain the colour of fruit. Enhancing the shelf life of fruits is the only remedy to full-fill the demand of market during off- season also (Bisen *et al*., 2012). Extension of storage life may be possible by checking the rate of transpiration, respiration and by checking fruit spoilage percent (Kumari and Dhingra, 2024).

Material and methods

Experimental location

The experiment was carried out at the laboratory of Horticulture Section, College of Agriculture, Dhule.

Material selection

Fresh, mature-green and uniform sized acid lime fruits of cv. Sai Sharbati were harvested from healthy trees of lime from nursery of Horticulture, College of Agriculture, Dhule. The fruits were washed thoroughly in running tap water to remove the adherent dirt material.

Application of edible coatings

Fruits were washed by running tap water. Water from fruit surface were removed with tissue paper and then kept in air, thus ready to be used for coating application. Washed fruits were divided into 9 groups (108 fruits/ group or treatment and 3 replications/ treatment). Each group was treated by different treatments. For chitosan and bee wax coating, fruits were dipped in different concentration of chitosan solution for 1 min and then air dried. For coconut oil and aloe vera gel coating, it was applied directly to fruit skin. All treatments were stored at ambient condition (30± 3^0C and 70-80% RH). The observations on various attributes were taken on same day of harvest and after 3 days interval. From each replication, 10 fruits were kept separately for physiological weight loss throughout the storage period.

Storage quality evaluation

Physical parameters such as fruit length, fruit diameter and fruit firmness and physiological parameters such as physiological loss in weight and shelf life

Fruit length (mm)

Fruit length was recorded with the help of vernier caliper and the reading was expressed in terms of milimetres.

Fruit diameter (mm)

Fruit diameter was recorded with the help of vernier caliper and the reading was expressed in terms of milimetres.

Fruit firmness (kg/cm^2)

The firmness of the fruit was tested by a penetrometer (Fruit Tester FT 327). The probe of the penetrometer was pierced through the fruit pulp and the pressure required was recorded at interval of 3 days. Each time punctures were made at two locations on fruit surface and average was computed. The firmness was expressed as kg/cm².

Physiological loss in fruit weight (%)

Acid lime fruits were weighed on weighing balance on the first day of the treatment and their mean weight was expressed in gram (g). Subsequently, every 3 days interval. They were weighed and the

loss in weight was worked out and expressed as percentage over the initial weight,

$$PLW\ (\%) = \frac{(\text{Initial weight-Final weight})}{\text{Initial weight}} \times 100$$

Shelf life (Days)

Shelf life of fruits was determined by recording the number of days to which fruits remained in acceptable condition during storage. When the spoilage of fruits exceeds 50 per cent, it was considered as not acceptable for consumption *i.e.* end of shelf life or storage life. Shelf life of acid lime was expressed in term of days.

Statistical Analysis

The data collected changes pertaining to physical and physiological parameters of fruits of acid lime and statistically analyzed by using Completely Randomized Block Design techniques as described by Panse and Sukhatme (1995). The appropriate standard error S.E (±) was calculated in each case. The critical difference (C.D.) at 5 % level of probability was worked.

Result and discussion

Fruit length (mm)

The data showed that, there was decrease in length of the fruits with the advancement of storage period irrespective to the treatments. Significantly maximum fruit length was recorded in coconut oil 100 % (36.16 mm) followed by chitosan 1.5 % (34.86 mm) while, the minimum fruit length was found in the control fruits (32.66 mm).

The coconut oil kept the fruits respiration rate constant while also preventing them from losing water through transpiration. The fruits under treatment were coated with a thin layer of coconut oil which prevented moisture loss and resulted in less turgidity loss. Also, because it makes impacts on ripening by decreasing ethylene evolution, firmness is retained and shrinking appears at a slower pace. This might be the explanation for the fruits length reduction being lower. Similar findings was noted by Guleria and Manisha, (2022) in acid lime during storage.

Fruit diameter (mm)

The fruit diameter decreased with increasing period of storage in all treatments and the decreasing trend is higher in untreated fruits. Significantly the maximum fruit diameter was recorded in coconut oil 100% (34.36 mm) followed by chitosan 1.5 % (32.13 mm) while, the minimum fruit diameter was found in the control fruits (29.50 mm). The coconut oil kept the fruits respiration rate constant while also preventing them from losing water through transpiration. The fruits under treatment were coated with a thin layer of coconut oil which prevented moisture loss and resulted in less turgidity loss. Also, because it makes impacts on ripening by decreasing ethylene evolution, firmness is retained and shrinking appears at a slower pace. This might be the explanation for the fruits diameter reduction being lower. Similar findings was noted by Guleria and Manisha, (2022) in acid lime during storage.

Fruit firmness (kg/cm^2)

Fruit firmness decreased with the advancement of storage period and the decreasing trend is higher in untreated fruits. Maximum fruit firmness was recorded in fruits treated with coconut oil 100 % (6.96 kg/cm^2) followed by chitosan 1.5 % (6.60 kg/cm^2). The minimum fruit firmness was found in control fruits (4.33 kg/cm^2).

Edible oils positively influence the conservation of firmness in fruits by decreasing water loss and fruit senescence and reducing cell wall degradation through inhibition of microbial activities. The present results are in agreement with the findings of

(Nasrin *et al*., 2018) who reported that coconut oil coated mandarin fruits were the most firm during storage period. Chitosan coatings also exerted a beneficial effect on fruit firmness throughout the storage period specially 1.0% and 1.5% chitosan coated mandarin preserved their firmness more efficiently than the 0.5% chitosan coated fruits. (Dulta *et al*., 2022) and (Yousefi *et al*., 2024) noted similar variations in fruit firmness of orange and acid lime fruits during storage respectively.

Treatment	**Fruit length (mm)**	**Fruit diameter (mm)**	**Fruit firmness (kg/cm^2)**
Chitosan 0.5 %	33.53	31.06	4.63
Chitosan 1 %	34.10	31.43	5.00
Chitosan 1.5 %	34.86	32.13	6.60
Coconut oil 100 %	36.16	34.36	6.96
Aloe vera gel 100%	34.40	31.93	5.70
Bee wax 0.5 %	33.96	31.26	4.93
Bee wax 1%	34.83	32.40	5.96
Chitosan 1% + Bee wax 1%	34.23	31.76	5.43
Control	32.66	29.50	4.33
SE (±)	0.18	0.27	0.03
CD at 5%	0.56	0.81	0.11

Table 1 : **Influence of different treatments on Fruit length, diameter and firmness**

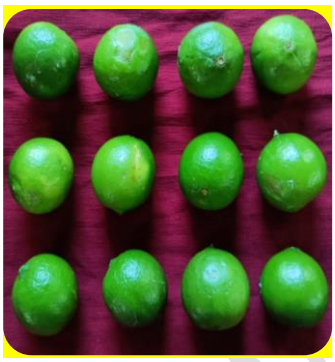
Physiological loss in weight (%)

The physiological loss in weight was significantly increased in all treatments with the advancement of storage period and the increasing trend in weight loss percentage was found maximum in control upto 21 days of storage. Minimum physiological loss in weight was recorded in the fruits treated with coconut oil 100% (5.36 %) followed by chitosan 1.5% (7.03 %). The maximum physiological loss in weight was recorded in control (31.86 %). Coconut oil coating closes the opening of stomata and lenticels thereby, reducing the transpiration and respiration rate and also reduce microbial activity. Edible coatings act as a barrier, thereby, restricting water transfer and protecting fruit skin form mechanical injuries as well as, sealing small wounds and thus delaying dehydration (Nasrin *et al*., 2018).

Treatment	Physiological loss in weight (%)	Shelf life (days)
Chitosan 0.5 %	24.43	16.30
Chitosan 1 %	17.03	16.50
Chitosan 1.5 %	7.03	19.50
Coconut oil 100 %	5.36	21.00
Aloe vera gel 100%	10.06	17.40
Bee wax 0.5 %	20.20	16.40
Bee wax 1%	8.26	18.30
Chitosan 1% + Bee wax 1%	14.23	16.70
Control	31.86	10.30
SE (±)	0.02	0.05
CD at 5%	0.08	0.17

Table 2: Influence of different treatments on Physiological loss in weight and days of Shelf life

Application of edible coatings



Fruits coated with coconut oil

Shelf life (days)

The shelf life (days) of the acid lime fruits were decreased as the storage period progressed in all the treatments. Among the different treatments, significantly highest shelf life was recorded in the fruits treated with coconut oil 100% (21.00 days) followed by chitosan 1.5 %, bee wax 1 %, aloe vera gel, chitosan 1% + bee wax 1%, chitosan 1%, bee wax 0.5% and chitosan 0.5% (19.50, 18.30, 17.40, 16.70, 16.50, 16.40 and 16.30 days) respectively. However, the minimum shelf life was recorded in control (10.30 days). According to Kaur and Kaur, (2020), maximum shelf life was retained by the fruits of Mandarin coated with coconut oil. This might be due to the fact that, coconut oil coatings might have closed the opening of stomata and lenticels results in the reduction of transpiration and respiration rate and also the microbial activity leading to an increase in shelf life with good acceptability. Pimsorn *et al*., (2022), shows the result of aloe vera gel coating of acid lime that, it increases shelf life of acid lime for about four days longer than the control (10 days).

Conclusion

It was observed in the present investigation that most of the physical *viz.*, (fruit length (mm), fruit diameter (mm) and fruit firmness (kg/cm^2) and physiological parameters *viz.*, physiological loss in weight (%) and shelf life (days) of fruit were significantly and positively influenced by 100 % coconut oil coating up to 21 days of storage at ambient room temperature. Hence, coating of acid lime fruits with 100 % coconut oil is useful for extending their shelf life and effective in stabilizing market demand.

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1.

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3.

References

Bisen, A., and Pandey, S. K. (2008). Effect of post-harvest treatment on biochemical composition and organoleptic quality in Kagzi lime fruit during storage. *Journal of Horticultural Sciences*, *3*(1): 53-56.

Bisen, A., Pandey, S. K. and Patel, N. (2012). Effect of skin coatings on prolonging shelf life of kagzi lime fruits (*Citrus aurantifolia* Swingle). *Journal of food science and technology*, 49(6): 753-759.

Dulta, K., Koşarsoy Agçeli, G., Thakur, A., Singh, S., Chauhan, P., and Chauhan, P. K. (2022). Development of alginate-chitosan based coating enriched with ZnO nanoparticles for increasing the shelf life of orange fruits (*Citrus sinensis* L.). *Journal of Polymers and the Environment*, 30(8): 3293-3306.

Guleria, A., and Manisha, K. (2022). Study the effect of different surface coating on shelf life of "kagzi lime". *International Journal of Innovative Science and Research Technology*, 7(4).

Kaur, G., and Kaur, A. (2020). Effect of various oil coatings on the quality and shelf life of Mandarin cv. Daisy. *Indian Journal of Pure and Applied Bioscience*, *8*(3), 209-220.

Kumari, S., and Dhingra, D. (2024). Postharvest Management of Fruits in India: A Review. *Journal of Agricultural Engineering (India)*, 61, 2.

Nasrin, T. A. A., Islam, M. N., Rahman, M. A., Arfin, M. S. and Ullah, M. A. (2018). Evaluation of postharvest quality of edible coated mandarin at ambient storage. *International Journal of Agricultural Research, Innovation and Technology*, *8*(1): 18-25.

Rangel, C. N., Carvalho, L. M. J., Fonseca, R. B. F., Sores, A. G. and Jesus, E. O. (2010). Nutritional values of organic acid lime. Journal of Food Science and Technology (JFST), Vol. **31** (4): 918-922.

Ray, A. B., Birthare, S., No, E. (2018). Guru Jambheshwar University of Science and Technology, Hissar. Scope, status and importance of fruits and vegetables industries in India and role of fruits and vegetables in Indian economy.

Roongruangsri, W., Rattanapanone, N., Leksawasd, N. and Boonyakiat, D.

(2013). Influence of storage conditions on physiochemical and biochemical of two Tangerine cultivars. *Journal of Agricultural Sciences*. Vol. **5**:70-84.

Selvaraj, Y. and Raja, M. E. (2000). Biochemistry of ripening of kagzi lime (*Citrus aurantiifolia* Swingle) fruits. *Indian Journal of Horticulture*. Vol. **57**: 1-8.

Shahid, M. N., and Abbasi, N. A. (2011). Effect of bee wax coatings on physiological changes in fruits of sweet orange cv. "blood red". *Sarhad Journal of Agriculture*, Vol. **27** (3): 385-394.

Uttekar, S. A. (2021). Effect of pre-harvest and post-harvest formulations of hexanal for extending shelf life of Acid Lime *(Citrus aurantifolia* Swingle*)* cv. Phule Sharbati (Doctoral dissertation, Mahatma Phule Krishi Vidyapeeth, Rahuri).

Virkar, A. M., and Garande, V. K. (2022). Extension of shelf life of minimally processed of sweet orange (*Citrus sinensis* Osbeck) cv. Phule mosambi. *The Pharma Innovation Journal* Vol. **11** (12): 5457-5461.

Wathore, D. S. (2024). Effect of micronutrients on growth, yield and fruit quality of acid lime *(Citrus aurantifolia* Swingle*)* cv. Sai Sharbati (Doctoral dissertation, Mahatma Phule Krishi Vidyapeeth).

Wijewardane, R. M. N. A. (2022). Evaluation of the effect of fruit coating on shelf life extension of lime (*Citrus aurantifolia*) under different storage condition. *Journal of Horticulture and Postharvest Research*, Vol. **5** (4), 337-348.

Yadlod, S. S., Bhalerao, R. V., and Pingle, S. N. (2018). Variability Studies of strains of kagzi lime (*Citrus aurantifolia* Swingle) in Latur district of Maharashtra, India. *Agricultural Science Digest-A Research Journal*, Vol. **38** (1): 48-51.