*International Journal of Tropical Agriculture*
Volume 39, Number (4) • 2021 : pp. 467-472
ISSN: 0254-8755

# RESPONSE OF POST HARVEST APPLICATION OF CHEMICALS AND DIFFERENT PACKAGING MATERIALS ON SHELF-LIFE OF STRAWBERRY (*FRAGARIA* × *ANANASSA* DUCH.) IN TERRACE GARDENING

**Rakesh Kumar* and Dr. R. S. Antil**

[1]*PhD Student, Amity Institute of Horticulture Studies and Research, Amity University, Noida (UP)*
[2]*Principal Advisor (Soil Science), Amity Institute of Horticulture Studies and Research, Amity University, Noida (UP)*

**Abstract:** Strawberry loses its market viability within a short period of time. Its shelf life can only be increased by scientific post-harvest handling including ecofriendly packaging materials and chemical treatments. Packaging materials minimize respiration and handling damage and enhance the freshness and quality of the fruit. Weight and decay losses were minimum in fruits treated with $CaCl_2$ 2% and packed in PET Punnets kept in cold condition (3-4$^0$C) gave better result on extension of storage period and considerably reduced the physiological loss in weight, decay losses and got highest organoleptic scores. The acidity, total soluble solids, total sugars and ascorbic acid content of fruits first showed increasing trend and then started decreasing during the storage. The qualities of untreated fruits deteriorated much rapidly than the treated fruits.

**Keywords:** Strawberry fruits, Shelf-life, Quality, Packaging. Storage

## INTRODUCTION

Strawberry (Fragaria x ananassa Duch.) is one of the most delicious, refreshing, nutritious and soft fruit of the world. It belongs to the Rosaceae family. It is highly perishable in nature and can't be stored for a longer period of time under room temperature and is subjected to heavy spoilage during transportation and storage. About 20-50 per cent fruit loss occurs as post-harvest decay in strawberry depending upon harvesting month, fruit maturity, transportation distance and method of packaging (Mingchi and Kojimo, 2005). Modified atmospheric packaging (MAP) using different films can be illustrated as one of the best and low cost technology to have a better shelf life with proper quality for a soft fruit like strawberry. A well-known benefit of MAP is to reduce high water loss by creating high humidity inside the packaging and with that the produce maintains freshness comparatively for a longer period. Singh *et al.* (2008) reported that the shelf life of strawberry increased up to six days when they were packed in high-density polyethylene pouches. Similarly, the shelf life of passion fruits increased up to five weeks when the fruits were waxed and packed in polyethylene terephthalate packaging (Singh *et al.* 2011). Packaging of fruits in polyethylene films creates modified atmosphere conditions around fruits which trigger the rise of CO2 and fall in O2 concentration inside package resulting in reduced rate of respiration, transpiration and other metabolic processes of fruit (Singh et al., 2018). Several chemicals are used to prevent the damage from fruit rot during storage. Dunn and Able (2005) reported that application of calcium delays the ripening, development of grey mold and produce quality fruits in strawberry. Storage of fresh strawberry, even for short periods is not recommended because of their perishability. Due to its climacteric nature, it ripen fast and get spoiled very easily. The post-

**Article History:** Received: 18 October 2021; Revised: 22 October 2021; Accepted: 4 December 2021

harvest losses of strawberry are high in tropical country like India. To improve the quality and their post-harvest life, mineral nutrition and packaging are fundamental tools for post-harvest management of highly perishable fruits like strawberry. Therefore, present study was undertaken to assess the response of chemicals and packaging on shelf life and fruit quality of strawberry.

## MATERIALS AND METHODS

The present study was conducted in the Krishi Vigyan Kendra, Ujwa, New Delhi for NCR region Delhi during 2016-2018 on the shelf-life of Strawberry cultivar. Fruits were harvested early in the morning in tray, selected for uniformity of size and colour and to remove field heat, fruits were kept at ambient conditions (15°C and RH 70%) under shade for 30 min. freshly harvested mature and uniform sized fruits were selected and divided into seven equal lots. Each lot consisted of six fruits. Fruits were washed with distilled water and allowed to dry under electric fan and thereafter subjected to treatments. Fruits were quick dip method was used for treating fruits with calcium chloride and calcium nitrate. Fruits were dried under fan drier for 30 minutes before packing. There were seven treatments including control (open ambient condition), Calcium chloride (2%) and calcium nitrate (1.5%) in combination with different packages (capacity 250g, size 15 x 10 x 4 cm, with 4 perforations of 3 mm dia) viz. polypropylene terephthalate (PET) punnets and High density polythene (HDPE) crates. Untreated fruits in each package were also kept as a treatment. Six packages in each treatment were kept at ambient condition and same set were also kept in cold condition (3-4$^0$C). Fruits under control were kept on tissue paper in open floor as well as in cold condition. Quality Evaluations: Six fruits per treatment were used for recording observations at 0, 3, 6 and 8 days of storage at ambient conditions. Organoleptic rating based on fruit colour, shape, texture, taste and flavour etc. was taken on 10 point scale. The cumulative physiolocal loss in weight of the fruit was determined by the formula suggested by Westwood (1979). The physiological loss in weight of the fruits in percent was calculated at alternate day's interval on initial weight basis using the following formula:

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

Physiological loss in weight was observed by weighing of fruits individually and compared with corresponding initial weight. Total soluble solids by hand refractometer, titrable acidity was determined by titrating juice against standard alkali solution using phenolphthalein as indicator, ascorbic acid by 2,6-dichlorophenol indophenol visual titration method, total sugar by Fehling's solution method and pH by pH meter. TSS was recorded with the help of a hand refractometer (0-32 $^0$B). The titratable acidity, sugar and ascorbic acid were calculated by method as suggested in A.O.A.C. (1980) and pH by pH meter.

## RESULTS AND DISCUSSION

### 1. Physiological studies

### 1.1. Physiological loss in weight

Data pertaining the physiological loss in weight in different packaging are presented in Table 1. The treatments were fruits treated with calcium chloride (2%), calcium nitrate (1.5%) and fruits without chemical treatment packed in PET punnets and HDPE crates and fruits put in room temperature i.e. without treatment. The physiological loss in weight was recorded for 0, 3, 6 and 8 days after storage (DAS) and it was found that no loss was observed at 0 DAS, Minimum physiological loss in weight was observed in the $CaCl_2$ (2%) treated fruits packed in PET Punnets (6.1%) followed fruits treated with $CaCl_2$ (2%) packed in HDPE Punnets (7.3%) at 3 DAS while the maximum physiological loss was observed in fruits put at Room temperature i.e. without any treatment (21.5%). Mean physiological loss was observed at 3 DAS was 11.59 per cent.

Similar trend in physiological loss in weight was observed at 6 and 8 DAS. Minimum physiological loss in weight was observed in the $CaCl_2$ (2%) treated fruits packed in PET Punnets (12.3 and 26.3%) followed fruits treated with $Ca(NO_3)_2$ (1.5%) packed in PET Punnets (14.5 and 29.3%) at 6 and 8 DAS while the maximum physiological loss was observed in fruits put at Room temperature i.e. without any treatment (37.5 and 56.4%). Mean physiological loss in fruit weight was observed at 6 and 8 DAS was 22.90 and 39.06 per cent, respectively. Kader, 1992 and Smith, 1992 observed that strawberry packed with PP punnets (500g) develops as internal atmosphere with gaseous composition recommended for strawberry. This might be due to high respiration and transpiration rates, high temperature, increased microbial infection, induce catabolic activity of strawberry fruits and had not control of loss of weight (Shin et al., 2008; Jouki and Khazaei, 2012; Srivastava and kumar, 2012). High respiration and transpiration rates, and also high catabolic process occur and thus fruits may be affected through severe microbial infection within storage period (Shin et al., 2008).

### 1.2. Decay loss

Data pertaining the decay loss in weight under the different packaging treatments are presented in Table 7. It was found that no decay loss was observed at 0 DAS, Minimum decay loss was observed in the $CaCl_2$ (2%) treated fruits packed in PET Punnets (3.4%) followed fruits treated with $Ca (NO_3)_2$ (1.5%) packed in PET Punnets (4.5%) at 3 DAS while the maximum decay loss was observed in fruits put at Room temperature i.e. without any treatment (42.5%). Mean decay loss was 13.17 per cent at 3 DAS. Minimum decay loss was observed in the fruits treated with $Ca (NO_3)_2$ (1.5%) packed in HDPE crates (12.3%) followed by fruits treated with $CaCl_2$ (2%) packed in PET Punnets (20.4%) at 6 DAS. The maximum decay loss was observed in fruits put at Room temperature i.e. without any treatment (82.4%). Mean decay loss of 28.80 per cent was observed at 6 DAS in strawberry. $CaCl_2$ (2%) treated fruits packed in HDPE crates resulted into lowest decay loss at 8 DAS i.e. 23.9 per cent while fruits put at Room temperature i.e. without any chemical treatment resulted into maximum decay loss (94.5%). The average decay loss in strawberry at 8 DAS was 48.70 per cent.

Different packaging films behaved differentially to regulate the fruit decay on different days under different storage conditions. This might be due to the property of packaging films to retain a higher level of CO2 inside the packages. Higher atmospheric CO2 level shows fungi static effect (Li and Kader, 1989). Similar findings were reported by Ozkaya et al. (2009), they also found the modified atmospherically packed strawberry fruits resulted in a lower decay loss than the control fruits (without packaging). These data substantiate the findings of Gupta et al. (1987) reporting that calcium compounds reduce the rate of weight and decay losses and decrease ethylene evolution and the fruit retained high T.S.S. and ascorbic acid content for longer periods than in control.

### 1.3. Organoleptic rating

Data pertaining to organoleptic rating of the fruits treated with different packaging treatments and put for 0, 3, 6 and 8 days are presented in Table 7. At 0 DAS at treatments received an organoleptic score of 9 and no difference in taste had been observed. $CaCl_2$ (2%) treated fruits packed in PET Punnets got highest organoleptic scores at 3, 6 and 8 DAS i.e. 7, 4 and 2 while the fruits put at Room temperature i.e. without any chemical treatments got least organoleptic scores i.e. 1, 0 and 0 at 3, 6 and 8 DAS respectively. The mean organoleptic scores at 3, 6 and 9 DAS was 4.57, 2.57 and 1.29, respectively. This might be attributed to the characteristic feature of this film having a proper balance for the permeability of CO2, O2 and RH, which maintained a better overall sensory quality in strawberry fruits. Although having an initial rise during storage, the overall sensory quality of strawberry fruits followed a decreasing trend. These findings are in close aggregation with the earlier findings of Garcia *et al.* (1998) and Shood *et al.* (2012), they observed fruits packed in different packaging films maintained acceptability for longer period as compared to un-wrapped fruits.

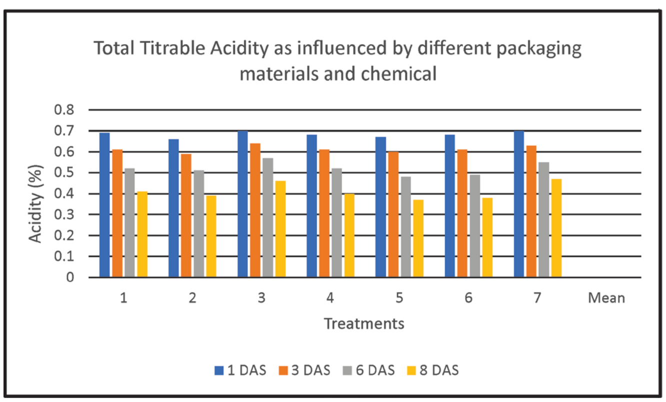
### 1.4. Quality Evaluations

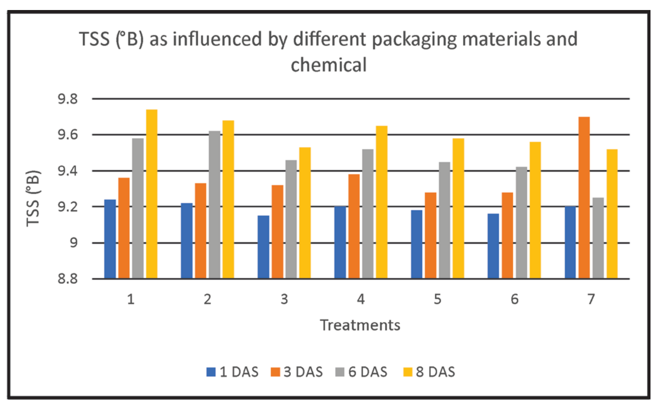
It has been seen from the result that the acidity decreased up to 6th day of storage with the value of 0.57% was recorded in treatment $CaCl_2$ (2%) treated fruits packed in PET Punnets and then increased slightly up to 8$^{th}$ day of storage, while the maximum acidity (0.72%) was recorded in control at 3rd day of storage (Table 1). The decrease in

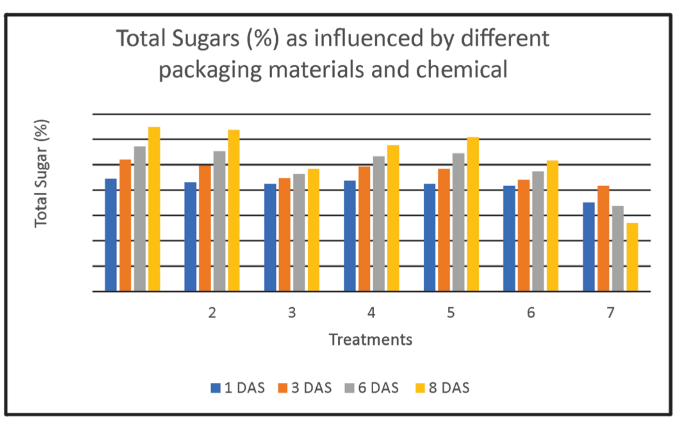
**Table 1: Physiological loss in weight (%) and decay loss (%) of strawberry fruits in different packaging**

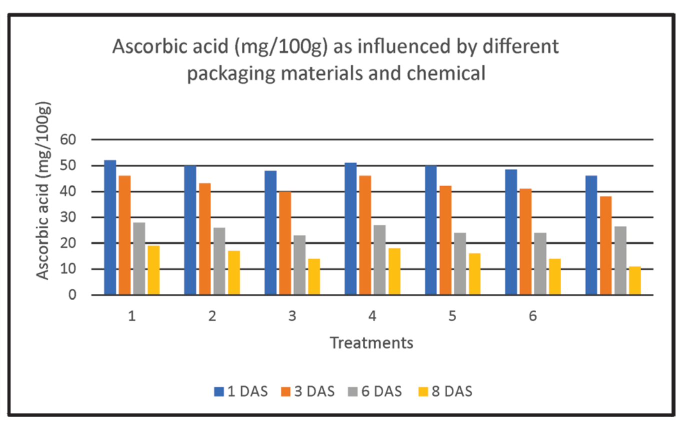
| *Treatments* | *Physiological loss in weight (%)* | | | | *Decay loss (%)* | | | | *Organoleptic rating (10-point scale)* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *O DAS* | *3 DAS* | *6 DAS* | *8 DAS* | *O DAS* | *3 DAS* | *6 DAS* | *8 DAS* | *O DAS* | *3 DAS* | *6 DAS* | *8 DAS* |
| $CaCl_2$ (2%) treated fruits packed in PET Punnets | - | 6.1 c | 12.3 c | 26.3 d | - | 3.4 c | 20.4 b | 46.1 b | 9 | 6.7 a | 3.7 a | 2.0 a |
| $Ca(NO_3)_2$ (1.5%) treated fruits packed in PET Punnets | - | 7.8 bc | 14.5 c | 29.3 d | - | 4.5 c | 23.0 b | 49.7 b | 9 | 5.7 a | 3.0 b | 2.0 a |
| Fruits packed in PET Punnets (no chemical) | - | 12.1 b | 23.9 b | 38.8 c | - | 16.2 b | 28.7 b | 51.5 b | 9 | 4.0 b | 2.3 c | 1.0 b |
| $CaCl_2$ (2%) treated fruits packed in HDPE crates | - | 7.3 bc | 14.7 c | 32.0 d | - | 10.7 bc | 18.6 bc | 23.9 d | 9 | 6.3 a | 3.7 a | 1.7 a |
| $Ca(NO_3)_2$ (1.5%) treated fruits packed in HDPE crates | - | 10.2 bc | 28.5 b | 42.7 bc | - | 6.5 c | 12.3 c | 34.0 cd | 9 | 4.3 ab | 3.0 b | 1.0 b |
| Fruits packed in HDPE crates (no chemical) | - | 16.1 ab | 28.9 b | 47.9 b | - | 8.4 b | 16.2 c | 41.2 bc | 9 | 3.3c | 2.3 c | 1.3 b |
| Control (Room temp.) | - | 21.5 a | 37.5 a | 56.4 a | - | 42.5 a | 82.4 a | 94.5 a | 9 | 1.7 cd | 0 d | 0 d |
| Mean | | 11.59 | 22.90 | 39.06 | | 13.17 | 28.80 | 48.70 | 9.00 | 4.57 | 2.57 | 1.29 |
| Significance (p=0.05) | - | ** | *** | ** | - | *** | *** | ** | - | ** | ** | NS |

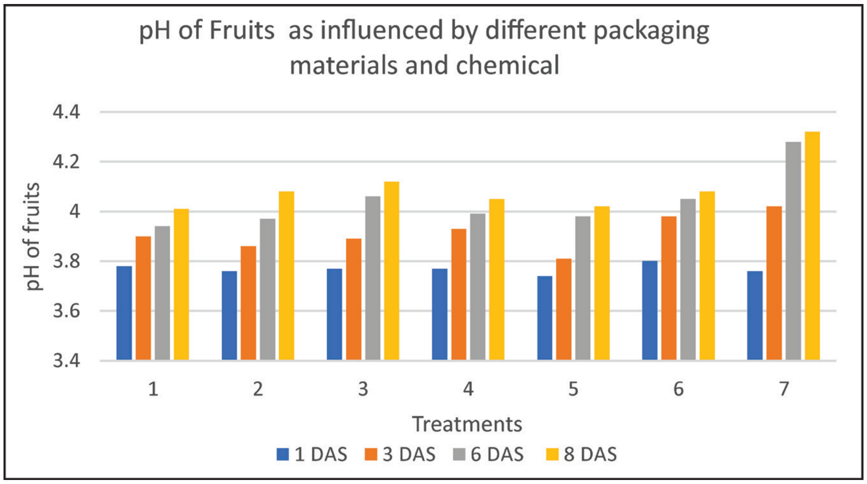
Means within columns separated by using Duncan's multiple range test P = 0.05.
NS, *, **, ***Non-significant or significant at P < 0.05, 0.01, or 0.001, respectively.






acidity may be attributed to conversion of organic acids into sugar by calcium. This result is in dose proximity with the findings of Jha et at (1998). The decrease in acidity storage is probably due to the utilization of acid in the respiratory process or by their conversion of sugar. Paraskevopoulou et al. (1995) supports the result.

Among the different treatments $CaCl_2$ (2%) treated fruits packed in PET Punnets was significantly superior in increasing the TSS (9.74 °B) than the other treatment up to 8th day of storage which was statistically at par with Ca (NO3) 2 at 1.5%. The increase in total soluble solids content due to $CaC1_2$ may be due to conversion of reserved starch and other polysaccharides to soluble form of sugars during storage. The increase of sugar is due to inhibition of the rate of metabolic process after harvest. However, these findings are in contrast with Upadhayaya and Sanghavi (2001). Similar results have been also reported by Singh et al. (1987). It has been clear from the data given in Table 2 that total sugars content (7.8%) increased considerably in fruits treated with $CaCl_2$, at 2% followed by Ca (NO3)2 (7.4%) up to 6th day of storage and thereafter, it decreased slightly. The increase in total sugar content of stored fruits may be attributed to quick metabolic transformation in soluble compounds and more conversion of organic acid in to sugar by calcium. This pattern of increasing in total sugar content is reported by Jha et at (1998).

Data given in Table 2 further revealed that the ascorbic acid content of harvested fruits was increased up to 6$^{th}$ day of storage and thereafter it decreased up to 8$^{th}$ day of storage. The maximum ascorbic acid content (78.5 mg/100g pulp) was recorded under $CaCl_2$ (2%) treated fruits packed in PET Punnets on 6$^{th}$ day of storage and minimum (53.5 mg/100g pulp) was recorded in control on 8$^{th}$ day of storage. The increase in ascorbic acid content of CaCl2 treated fruits may be due to slower rate of oxidation of ascorbic acid (Gautam and Chundawat 1989). Minimum pH (3.94) was noticed in $CaCl_2$ (2%) treated fruits packed in PET Punnets followed by $Ca(NO_3)_2$ (1.5%) treated fruits packed in PET Punnets (3.97), respectively. Maximum pH (4.28) was observed in control followed by 4.05 in Fruits packed in HDPE crates (no chemical). The changes in pH were inverse with the titrable acidity. It coincides with the findings of Efiurwerwere and Uwanogh (1990).

## CONCLUSION

Taking into consideration all the above facts and figures regarding the quality and shelf life of strawberry at room temperature, the fruits treated with $CaCl_2$ 2% and packed in PET Punnets kept in cold condition (3-4$^0$C) gave better result on extension of storage period and considerably reduced the physiological loss in weight, decay losses and got highest organoleptic scores The qualities of untreated fruits deteriorated much rapidly than the treated fruits. The fruits treated with $CaCl_2$ (2%) treated fruits packed in PET Punnets proved best over the other treatments. The fruits were found to be in marketable condition even after eight days of storage.

## References


A.O.A.C., 1980. Official methods of analysis. Association of official analytical chemists. Washington, D.C. USA.

Dunn, J.L., Able, A.J., 2006. Pre-harvest calcium effects on sensory quality and calcium mobility in strawberry fruit. Acta Hortic. 708, 307–312.

Efiurwerwere, B.J.O. and Uwanogh, G.U. 1990. Effect of packaging material following ethanol and benomyl treatments on chemical and microbiological changes in tomato. Indian Food Pakers 78(6):28-29.

Garcia, J.M., Medina, R.J., Olias, J.M. (1998). Quality of strawberries automatically packed in different plastic films. *J.Food Sci*., 63(6): 1037-41.

Gautam, S.K. and Chundawat, B.S. (1989). Indian J. Hart., 46: 310-315.

Gupta, O.P., Siddiqui, S. and Chauhan, K.S. 1987. Evaluation of various calcium compounds for increasing the shelf life of ber fruit. Indian J. Agric. Res. 21(2):65-70.

Jha, K.K. et al. (1998). Indian J. Hort., 55(3); 218-222. Singh, R.N. et a1. (1987). Prog. Hart., 19(1-2): 1-9.

Jouki, M. and Khazaei, N. 2012. The effect of modified atmosphere packaging and calcium chloride dipping on the quality and shelf life of Kurdistan strawberry, Food Process Technol.,3(10):2 –7.

Kader, A.A. 1992. Modified atmospheres during storage. In. Post-harvest Technology of Horticultural crops, Kader, A.A. (Ed.), p. 85-92. Publ. 3311.

Kirad, K.S., Barche, S., Dash, A. and Sharma R.K. (2007). Responses of different packaging materials and chemicals on the shelf life of strawberry (*Fragaria* × *ananassa* Duch.) and correlation between different traits. *Acta Hort.*, 746: 89-95.

Mingchi, L. and Kojimo, T. (2005). Study on fruit injury susceptibility of strawberry grown under different soil moisture to storage and transportation. *J. Fruit Sci.*, 22: 238-242.

Paraskevopoulou, P.G., Valiijkabis, M., Dogras, C., Gerasopoulos, D., Olympious, C.H. and Passam, H. 1995. Effect of temperature, duration of cold storage and packaging on post-harvest quality of strawberry fruit. Acta Hort. 379:337-344.

Shin, Y., Ryu, J.A., Liu, R.H., Nock, J.F. and Watkins, C.B. 2008. Harvest maturity, storage temperature and relative humidity affect fruit quality, antioxidant contents and activity, and inhibition of cell proliferation of strawberry fruit, Postharvest Biol. Technol., 49: 201 – 209.

Singh A, Nath A, Buragohain J and Deka B C. 2008. Quality and shelf life of strawberry fruits in different packages during storage**.** *Journal Food Science and Technology* **45**(5): 439–42.

Singh A, Yadav D S, Patel R K, Nath A and Bhuyan M. 2011. Wax coating and padding materials influence quality and shelf life of purple passion fruit during storage. *Indian Journal of Horticulture.* **68**(2):246–9.

Smith, R.B. 1992. Controlled atmosphere storage of 'Redcoat' strawberry fruits. J Amer Soc Hort Sci 117: 260-264.

Sood, Monika, Raj Kumari Kaul, and P. Sood. "Improving strawberry fruit storability by application of post-harvest chemical treatments." *Applied Biological Research* 14.2 (2012): 125-130.

Srivastava, R.P. and Kumar, S. 2012. Fruits and vegetable preservation. Important methods of analysis of fruits and vegetables and their products, IBDC Publishers, India.353 – 364.

Upadhayaya, A.K. and Sanghavi, K.V. 2001. Effect of various chemical and packaging methods on storage quality of strawberry cv. Chandler. Advances in Plant Science 14(2):343-344.