

## Optimizing low temperature storage techniques for extending avocado shelf-life

**Avocado fruit is rapidly gaining popularity among Indian farmers, traders and consumers due to its high nutritional value, more health benefits and increased international trade. As Avocado is a minor crop in India, not much information is available on its cultivation and postharvest handling. Climacteric nature of avocado fruit makes it ripe within a week after the harvest. Critical temperatures for cold storage of avocados are standardized in countries like Mexico, Brazil, USA and Peru, where it is grown at a commercial scale. However, storage temperature differs among the growing areas and cultivars. In India, avocado cultivation is especially picking up pace in southern states because of its high price and more demand in the market. However, the shorter shelf life and lack of information on optimum storage temperature result in increased postharvest loss and lower profit to growers and traders. Hence, understanding fruit physiology and knowing the optimum low temperature for cold storage are imperative crucial to extend the shelf-life of avocado fruits for longer duration with better fruit quality and least spoilage.**

**A**VOCADO fruit (*Persea americana* Mill.), renowned for its rich flavour, creamy texture and nutritional quality especially unsaturated fatty acids, has been gaining immense popularity. The perishable nature of avocados presents a significant challenge for producers, distributors, and retailers aiming to extend their shelf life while maintaining quality. Low temperature standardization emerged as a promising solution to address this challenge, offering a systematic approach to preserve the avocado freshness and enhance its marketability. By meticulously controlling temperature and storage conditions, the ripening process can be slowed down to prolong the fruit freshness. In addition, identification of critical temperature for low temperature storage of avocado fruit is essential for developing protocols for long distance transportation as well. This article explores the standardization of critical low temperature for storage to extend shelf life and highlights its potential to reduce waste, enhance marketability and satisfy consumer demand for premium produce.

### Avocado fruit and storage conditions

Fully matured avocado fruits (Accession CHES-HA-I/I and CHES-HA-VII/I) which were grown at ICAR-Indian Institute of Horticultural Research (IIHR)-Central Horticultural Experimental Station (CHES), Hirehalli, Karnataka, India, were harvested and brought to postharvest handling laboratory at ICAR-IIHR, Bengaluru. Fruits were cleaned with 100 ppm chlorinated water to remove the dust and microbial load present on

the fruit surface. These avocados were separated into 4 groups and kept into ventilated corrugated fibre board (CFB) boxes and then stored at different low temperatures (5, 9 and 12°C with 90-95% relative humidity, RH) and room temperature (26-32°C with 55-62% RH) as control. Fruit samples from each replication were withdrawn at definite time intervals for analysis of various physical, physiological and quality parameters such as physiological loss in weight (PLW), fruit firmness, respiration and ethylene production rate, ripening rate, changes in fruit colour ( $L^*$ ,  $a^*$ ,  $b^*$ ), spoilage percentage, total soluble solids (TSS), acidity, carbohydrates, protein, fat, total phenolic content (TPC) and antioxidant activity.

### Low temperature standardization for avocado fruits

Storage temperature for fruits is a critical factor to maintain the fruit quality and to extend the shelf life. Low temperature storage reduces the weight loss of fruits, decreases the respiration and ethylene production rate, and associated biochemical changes as well. It was reported that the rate of biochemical reactions reduced by half for every 10°C drop in temperature and can double the shelf life than those stored at ambient condition. However, temperature below critical level can induce chilling injury and deteriorate the fruit quality.

In a study on extending avocado shelf life, two varieties (CHES-HA-I/I and CHES-HA-VII/I) were stored at different temperatures: 5°C, 9°C, 12°C with 90-95% humidity, and room temperature. Among all the storage temperatures, maximum shelf life (21 days) was recorded

in avocado fruits stored at 9°C in both the accessions with higher fruit firmness, lower PLW (6.09 and 6.15% in CHES-HA-I/I and CHES-HA-VII/I respectively), reduced respiration, ethylene production, surface colour change and ripening rate. Moreover, fruits stored at 9°C had significantly higher fruit quality in terms of TSS, acidity, protein, carbohydrates, fat and antioxidant activity as compared to 12°C storage. However, avocados stored at 5°C failed to ripe even after 21 days of storage due to incidence of chilling injury (CI). CI symptoms which are characterised by water soaked area on the fruit surface, browning of fruit pulp, failure of the fruit to ripe and fruit hardening, started to appear from 14<sup>th</sup> day of storage and increased with the increase in storage days. Furthermore, fruits stored at 12°C had better shelf life (up to 14 days) but physiological processes and loss of fruit quality were faster as compared to fruits stored at 9°C. The minimum shelf life (4 and 6 days in CHES-HA-VII/I and CHES-HA-I/I respectively) with higher physiological activities and lower fruit quality were recorded in the avocado fruits stored under room temperature. The postharvest spoilage causes serious economic losses in avocado fruit during storage. The application of different storage temperatures profoundly influenced the occurrence of the disease symptoms. Development of disease symptoms were more prominent in fruits stored at room temperature than low temperatures. Cold storage recorded no spoilage till 28<sup>th</sup> day in fruits stored at 9°C, whereas fruits stored at 12°C developed spoilage on 14<sup>th</sup> day of storage. This study clearly shows that storing avocados at 9°C is the best bet for extending their shelf life up to 21 days with minimal spoilage and top-notch quality.

### Benefits of low temperature storage in avocado fruits

**Extended shelf-life:** Low temperature storage slows down the ripening process, thereby extending the shelf life of avocado fruits. This allows retailers to keep avocados fresh for a longer period, reducing spoilage and waste.

**Better fruit quality:** Cold storage helps to maintain the quality of fruits by slowing down the degradation of texture, flavour, and nutritional content. Avocados stored at lower temperatures are less likely to develop off-flavours or become mushy.

**Preservation of nutrients:** Cold temperatures can help to preserve the nutritional content of avocados, including vitamins, minerals, and antioxidants. This is important for ensuring consumers receive the full health benefits of avocados even after storage.

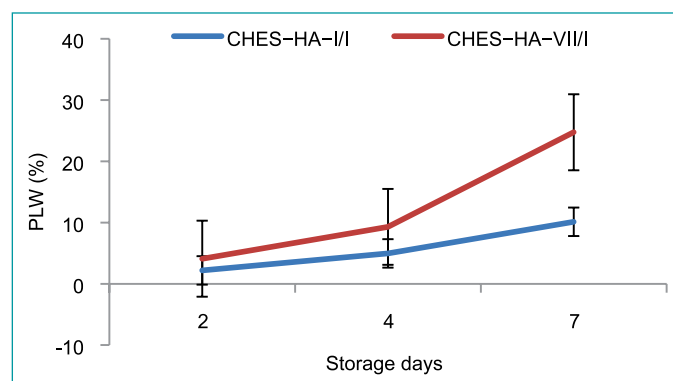
**Market flexibility:** Low temperature storage provides greater flexibility in managing inventory and distribution. Retailers can store avocados for longer periods without compromising quality, allowing them to better respond to fluctuations in demand.

**Year round availability:** Storage of avocado fruits at critical low temperature enables better storage conditions during peak production and can be released gradually into the market as and when needed. This helps to ensure a consistent supply of avocados throughout the year, even during off-season.

**Export opportunities:** Low temperature storage facilitates the export of avocados to distant markets where

**Table 1.** Effect of different storage temperatures on shelf life of avocado fruits

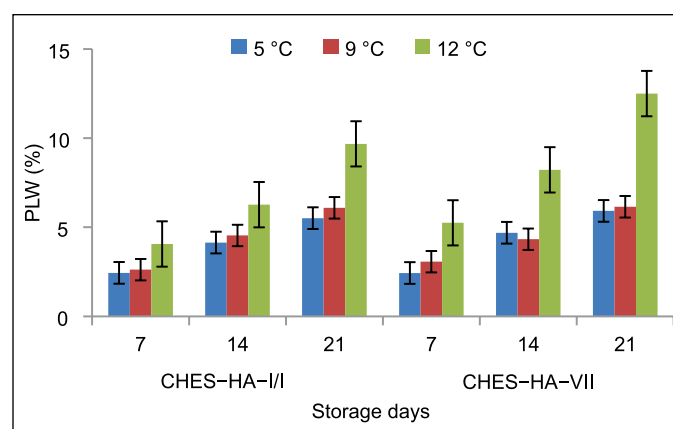
| Storage temperature | Accession<br>Number of days taken for ripening |                       |
|---------------------|------------------------------------------------|-----------------------|
|                     | CHES-HA-I/I                                    | CHES-HA-VII/I         |
| Room temperature    | 6 Days                                         | 4 Days                |
| 5°C                 | 28 Days (not ripened)                          | 28 Days (not ripened) |
| 9°C                 | 21 Days                                        | 21 Days               |
| 12°C                | 14 Days                                        | 14 Days               |



**Influence of room temperature on physiological loss in weight (PLW) of avocado fruit (Acc. CHES-HA-I/I and CHES-HA-VII/I) during 7 days of storage**

they may not be locally available. By maintaining quality during transportation, avocados can reach consumers in different regions while still being fresh and nutritionally good.

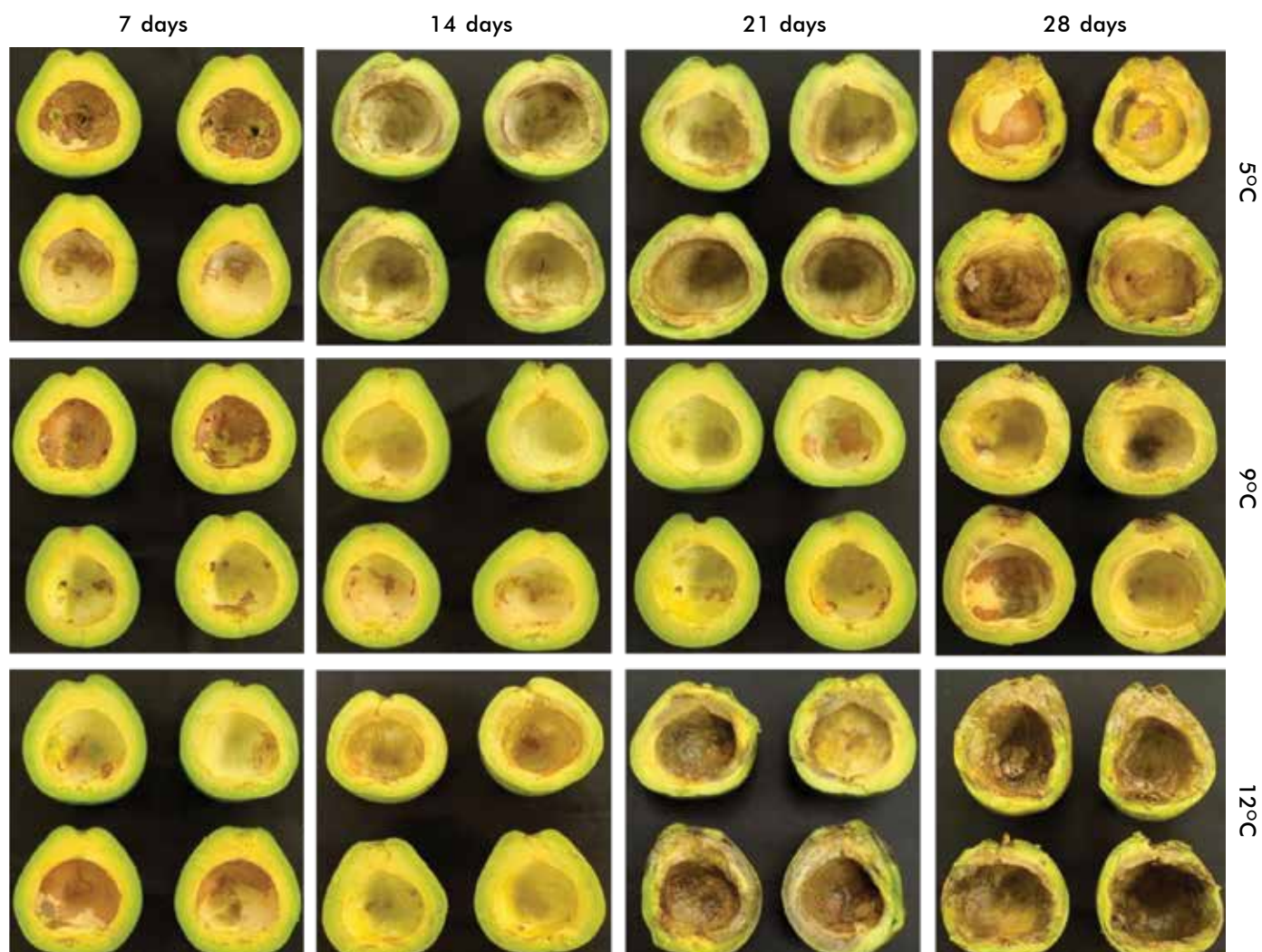
**Reduced postharvest losses:** By slowing down physiological processes and reducing the risk of spoilage, low temperature storage minimizes postharvest losses of avocado fruits. This is particularly beneficial for farmers, distributors, and retailers, as it allows them to reduce waste and maximize profits.



**Effect of different low temperatures on physiological loss in weight (PLW) of avocado fruit (Acc. CHES-HA-I/I and CHES-HA-VII/I) during 21 days of storage**

### SUMMARY

The low temperature standardization (9°C) in avocado fruits is designed to extend the shelf life by slowing down ripening and other physiological processes. Storage of



Changes in avocado fruits (Acc. CHES–HA–VII/I) stored at different low temperature

avocado fruits at optimum or critical low temperature maintains fruit freshness and quality for longer period during transportation and distribution, which reduces waste and enhances the market availability. In addition, cold storage not only benefits producers and distributors economically, but also contributes to sustainable food

practices by reduced food waste.

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### Infestation of lesser grain borer on roasted makhana seeds under storage

The internal stored grain insect (lesser grain borer), *Rhizopertha dominica* (Coleoptera: Bostrichidae) was found infesting on the roasted makhana seeds of 3 standard size grades, i.e. 7 mm, 9 mm and 11 mm. It was recorded that insects preferred to feed on 11 mm size seeds, followed by 9 mm and 7 mm, respectively. Both grub and adult stages were able to cause substantial damage. The adult laid the eggs on the seeds by entering inside the kernels through the apical natural opening. The average temperature and relative humidity for *R. dominica* development was maintained as  $32.5 \pm 1^\circ\text{C}$  and  $70 \pm 5^\circ\text{C}$ , respectively. It took 35–50 days for completing its life cycle, which included four stages: egg, larva, pupa and adult. Females laid about 200–500 eggs in their lifetime, singly. Incubation period lasted for  $5 \pm 0.3$ – $9 \pm 0.4$  days, while larval and pupal period took  $30 \pm 5$  and  $8 \pm 2$  days, respectively. Mean longevity of adult male and female was 26 and 17 weeks, respectively. The damage potential was assessed using the artificial infestation (purposive samples) with different numbers of tested insect. The study indicated that significant loss of roasted makhana seeds during 15 days of storage with  $40 \pm 1.24\%$  losses, caused by 10 adults per 100g seeds. The total quantitative losses observed for 6 months storage period was  $64 \pm 1.16\%$  in the samples with 10 adults per 100g of roasted makhana seeds. The initial losses were very high and became slow after 20 days. Presently available method of fumigation by aluminium phosphide was practised and found feasible for the insect control.



Internal makhana feeding



Lesser grain borer (adult and grub)

Source: ICAR Annual Report 2022-23