



# Effect of Different Storage Methods on the Shelf Life of Guava Fruits and Some Quality Indicators

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Guava is fifth most important fruit crop of India in production after banana, mango, citrus and papaya. Guava fruits are widely used by consumers as a fresh or are processed into a variety of value-added products in the food industries such as jam, jelly, cheese, nectar, paste. Guava fruits without any treatment and wrapper (1000g) were placed over perforated plastic round basket and stored under Room storage, Refrigeration and zero energy cool chamber (ZECC) up to 5 days with thrice replication. The moisture (%), mass (g), physiological loss in weight (PLW), shrinkage (%) and colour of guava was evaluated. It is clear from that the shelf life of guava were increased considerable by keeping them in room storage, Refrigeration and ZECC. Low PLW and shrinkage was noticed under refrigeration and ZECC throughout the period of storage. Lowest decrement in

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PLW and shrinkage was observed in Zero energy cool chamber, refrigeration as compared to room storage condition. ZECC is suitable for increasing shelf life of fruits and vegetables without non-renewable energy sources.

**Keywords:** Room storage; refrigeration; zero energy cool chamber; physiological loss in weight; guava.

## ABBREVIATIONS

PLW : Physiological loss in weight;  
ZECC : Zero energy cool chamber.

## 1. INTRODUCTION

India's total fruits and vegetables production is lost during harvest, storage, grading, transport, packaging and distribution in a year which reduces the growers share. Between 20 and 30% of total fruit production goes to waste owing to spoilage at various steps of the postharvest chain, reducing per capita availability of fruits to around 80 g per day which is almost half the requirement for a balanced diet. The fruit processing sector has grown at a rate of about 20% per annum [1]. Hence, there is a need for maximum commercial utilization of fruits and vegetables. Hence, preserving these types of foods in their fresh form demands that the chemical, bio-chemical and physiological changes are restricted to a minimum by close control of space temperature and humidity [2].

Due to their highly perishable nature, about 20-30% of total fruit production and 30- 35% of total vegetable production go waste during various steps of the post-harvest chain the lack of sufficient cool storage space at farm level and refrigerated storage at market level further enhances loss of fruits and vegetables [3]. Reducing the losses in postharvest fruit and vegetable operations is a worldwide goal [4]. The zero energy cool chambers working on the principle of evaporative cooling was though developed earlier, the effort to popularize this low-cost storage structure for on farm storage of perishables is snowballing only now. This could be easily constructed by the farmers themselves using locally available materials and could help in retaining the freshness of vegetables for a short period so that the farmers can store their produce for few days and can send the bulk of their commodity to the wholesale market avoiding distress local sale through middlemen. Temperature and humidity play major role in storage of fruits and vegetables. Temperature is the single most important factor affecting the

deterioration rate of freshly harvested commodities also, proper relative humidity is required to be maintained during storage [5].

The storage life of fruits and vegetables can be extended greatly by removing the field heat and applying cooling as soon as possible after harvesting. The optimum storage temperature of most fruits and vegetables is above their freezing point [6]. Proper storage is an important for marketing and distribution of horticultural commodities. Storage also balances the daily fluctuations of supply and demand [7].

Storage of horticultural products inside the cool chamber has showed reduction in physiological loss in weight, optimum color, better firmness and extended shelf life by 1–2 weeks in other parts of the country. Cool chambers are effective in maintaining the fruit acceptability for a longer period and minimizing the weight loss during storage [8]. Relatively lower weight loss of fruits and vegetables under evaporative cooler than that of ambient has been reported by many researchers. The least deterioration in quality parameters of tomato such as TSS, acidity and ascorbic acid content when stored in zero energy cool chamber reported by [9].

One of the most common fruit crops is guava, which usually takes 17 to 20 weeks from fruit set to maturity. Guava is fifth most important fruit crop of India in production after banana, mango, citrus and papaya. Guava fruits are widely used by consumers as a fresh or are processed into a variety of value-added products in the food industries such as jam, jelly, cheese, nectar, paste and other similar items because of high pectin content of fruits [10]. The fruits of guava show climacteric type of pattern in ripening and its shelf-life period ranges from 4-5 days at room temperature and ripen rapidly after harvesting because of having high moisture content. The different storage techniques and postharvest treatments are available to increase the shelf-life of guava fruits [11].

Slower rate of change of physicochemical constituents in fruits stored in cool chamber

reported by [12]. Weight loss of fresh tomato has been reported to be primarily due to transportation and respiration, and limited shelf-life and losses in quality have been identified as the major problems faced in the marketing of fresh tomatoes [13]. Zero energy cool chambers along with packaging materials, ventilation and antifungal treatments can help in minimizing the losses of ascorbic acid in the stored lemon fruits to some extent compared to the storage under ambient conditions of storage [14].

## 2. MATERIALS AND METHODS

The Zero-Energy Cool Chamber is developed under RKVY funded project entitled "Establishment of Agro Processing Centre" in 2021. Bricks, cement mortar (1:10), riverbed sand, brick batts, gunny bags were used for development of zero energy cool chamber (ZECC). Digital electronic balance, thermometer, hydrometer and water supply system were used during experiments. The development of ZECC was done with some modifications of the design of ZECC recommended by [15,16].

Zero energy cool chamber (2 nos.) having outer dimension 210×210×50 cm and inner size 110×110×40 cm was constructed with double brick walls using cement mortar (1:10) leaving a 25 cm spacing them. Photographic view of ZECC is shown in Fig. 1. The cavity of between brick walls was filled with riverbed sand. Out of two structures, the first made of without cement mortar and second with plaster inner and outer side of structure. In present study with plaster ZECC was used for experiment of guava fruit.

The inner floor of structure was made with brick and plastered with cement mortar. The top of the storage space was covered with plastic sheet. All two structure were covered with tin shade. Water supply was made through 1 inch diameter plastic pipe spread all side in cavity with small holes which is connected to rooftop water tank. The sand used in cavity were completely moistened till they got saturated. It was ensured that before actual recording of temperature and relative humidity data, the cool chamber was thoroughly wet. Water was supplied carefully in order to prevent flowing out of sand from the cavity of the walls. The whole experiment was conducted during month of April. The temperature and relative humidity of the ZECC and ambient under shed were recorded one time at 1.00 pm each day with the help of liquid-in-glass thermometer and hygrometer made of India with least count of 0.5°C and ±1%, respectively.

Freshly harvested 1000 g guava of uniform shape and size, firm texture and properly mature were brought from local market of Meerut and sorted out for elimination of brushed, punctured and damaged materials generally occur during transport. Soon after sorting, the fruits were washed thoroughly in running water, drained and wiped out with tissue papers. Guava fruits without any treatment and wrapper (1000 g) were placed over perforated plastic round basket and stored under Room storage, Refrigeration and zero energy cool chamber (ZECC) up to 5 days with thrice replication. The moisture (%), mass (g), physiological loss in weight (PLW, %), shrinkage (%) and colour of guava were evaluated. Data were noted every day at 4.00 pm



Picture 1. Zero energy cool chamber

in the evening, the weighing of guava was done with help of electronic balance with least count of 0.1 g while the color of fruits by lightness meter made of India. The shelf life and marketability of stored guava was evaluated on the basis of all the observation data.

### 3. RESULTS AND DISCUSSION

Guava fruits (1000 g) were placed over perforated plastic round basket and stored under Room storage, Refrigeration and zero energy cool chamber upto 5 days with thrice replication. The moisture (%), mass (g), physiological loss in weight (PLW, %), shrinkage (%) and colour of guava were evaluated. Data were noted each day at 4.00 pm in the evening and the weighing of guava was done with help of electronic balance while color of fruits by lightness meter (Scale: lightness '100' and darkness '0').

Variation in quality parameters like moisture (%), mass (g), physiological loss in weight (PLW, %), shrinkage (%) and colour of guava as affected by different storage systems are reported in Table 1. From the Fig. 1, It reported that the mass of guava was lose higher in room storage (1000 to 910.8 g) followed ZECC (1000 to 957.4 g) and lowest in refrigeration (1000 to 964.2 g) and

similarly in case of moisture (%) was lose higher in room storage (502.40 to 448.67%) followed ZECC (502.40 to 476.74%) and lowest in refrigeration (502.40 to 480.84%) is shown in Fig. 2.

It is clear from that the shelf life of guava was increased considerable by keeping them in room storage, Refrigeration and ZECC. Low PLW and shrinkage was noticed under refrigeration and ZECC throughout the period of storage (Fig. 3). PLW was observed lower on second day of storage and there after suddenly increased on third day. It appears that high humid condition (78 to 84%) and comparatively low temperature (23.4 to 26.9°C) under zero energy cool chamber retarded the metabolic activities through respiration and transpiration, which resulted the longer shelf life and smaller physiological loss in weight (PLW) during storage period (Khan and Samsher, 2001). Similarly, lowest moisture and mass loss was observed at refrigeration and followed by ZECC and highest was at room storage due to higher temperature of ambient (33.0 to 37.8°C). The loss in PLW is an indication of moisture loss from the fruits which renders fruits unmarketable as they not only lose colour, freshness and crispiness but also the palatability. Thus, the moisture loss from guava cannot be taken as mere loss in weight of

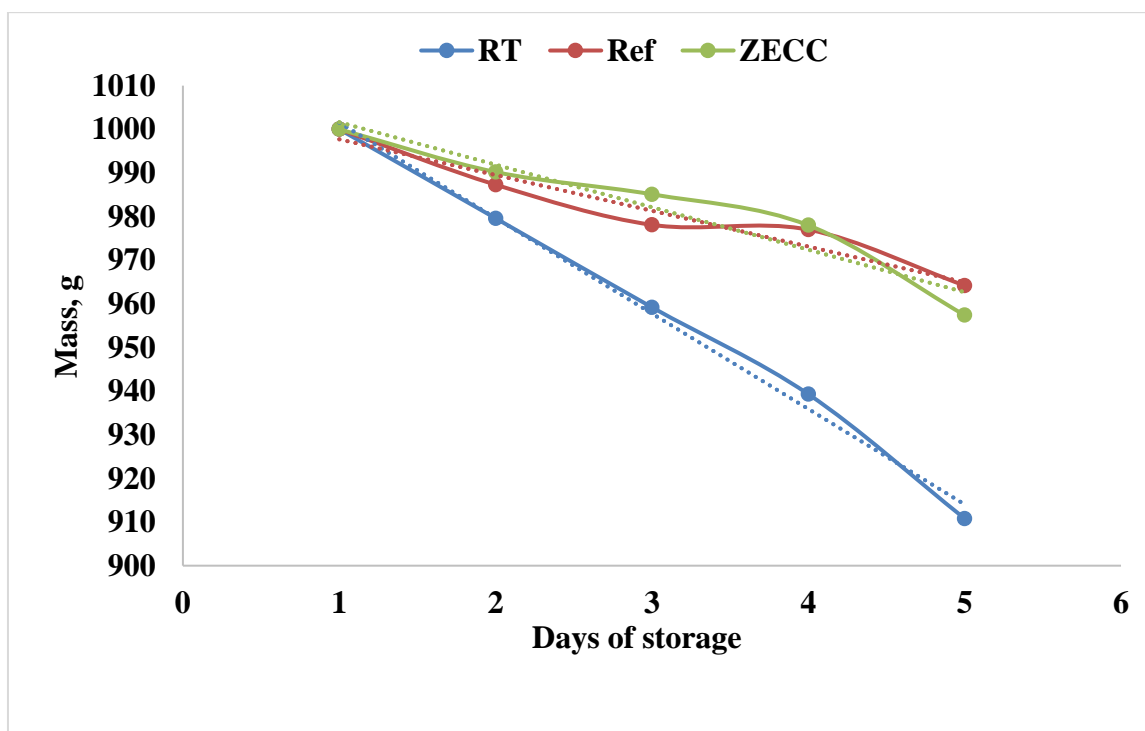


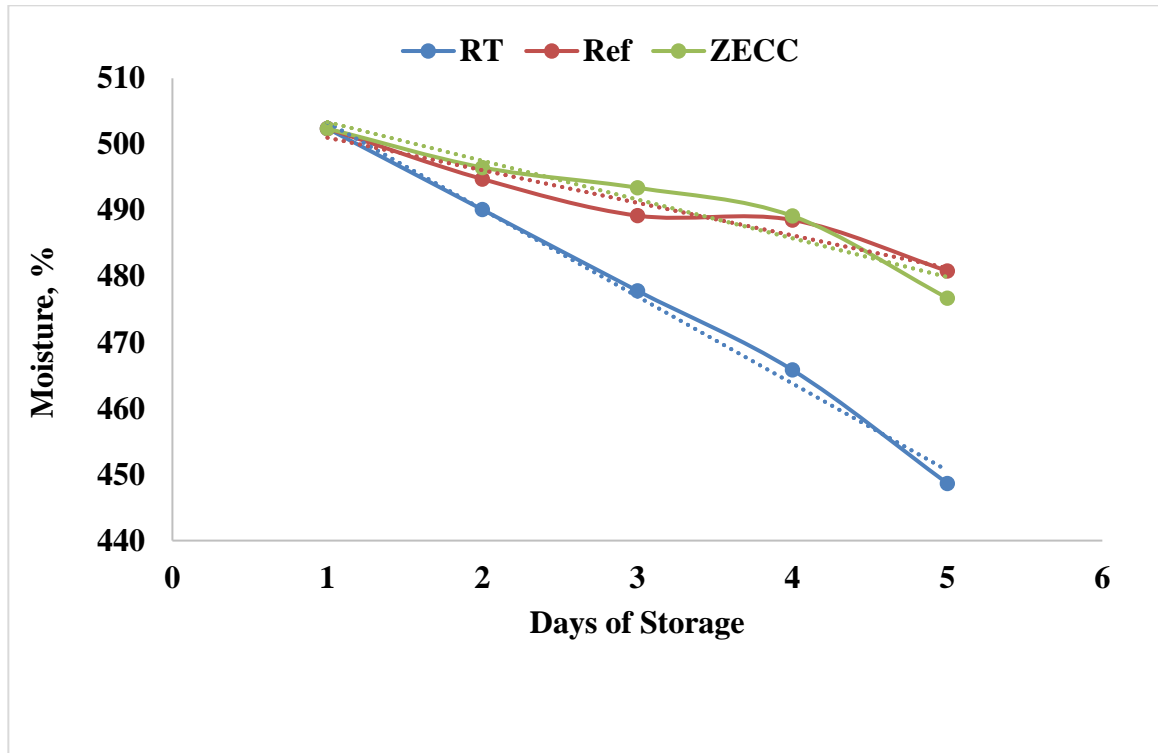
Fig. 1. Effect of different storages on mass (g) in guava fruits

**Table 1. Effect of different storage conditions on some quality indicators of guava fruits**

<b>Day of storage</b>	<b>Moisture, %</b>	<b>Mass, g</b>	<b>PLW, %</b>	<b>Shrinkage, %</b>	<b>Colour</b>
<b>Room storage</b>					
1	502.40	1000.0	0	0	14.70
2	490.12	979.6	2.04	2.18	19.00
3	477.83	959.2	4.08	5.75	16.10
4	465.84	939.3	6.07	14.45	14.80
5	448.67	910.8	8.92	15.19	13.50
<b>R<sup>2</sup></b>	<b>0.9945</b>	<b>0.9945</b>	<b>0.9945</b>	<b>0.9326</b>	<b>0.4941</b>
<b>Reg. Eq.</b>	<b>y = -13.174x + 516.49</b>	<b>y = -21.87x + 1023.4</b>	<b>y = 2.187x - 2.339</b>	<b>y = 4.265x - 5.281</b>	<b>y = -0.7524x + 17.986</b>
<b>Refrigeration</b>					
1	502.40	1000.0	0	0	15.95
2	494.75	987.3	1.27	1.28	15.10
3	489.21	978.1	2.19	1.88	15.20
4	488.55	977.0	2.30	2.18	13.90
5	480.84	964.2	3.58	7.88	13.90
<b>R<sup>2</sup></b>	<b>0.9489</b>	<b>0.949</b>	<b>0.9490</b>	<b>0.7488</b>	<b>0.6651</b>
<b>Reg. Eq.</b>	<b>y = -4.932x + 505.95</b>	<b>y = -8.19x + 1005.9</b>	<b>y = 0.819x - 0.589</b>	<b>y = 1.666x - 2.354</b>	<b>y = -0.267x + 15.743</b>
<b>Zero Energy Cool Chamber (ZECC)</b>					
1	502.40	1000.0	0	0	15.60
2	496.50	990.2	0.98	0.98	13.80
3	493.43	985.1	1.49	4.08	13.80
4	489.15	978.0	2.20	6.21	14.30
5	476.74	957.4	4.26	6.54	15.30
<b>R<sup>2</sup></b>	<b>0.9283</b>	<b>0.9283</b>	<b>0.9283</b>	<b>0.9443</b>	<b>0.0004</b>
<b>Reg. Eq.</b>	<b>y = -5.867x + 509.25</b>	<b>y = -9.74x + 1011.4</b>	<b>y = 0.974x - 1.136</b>	<b>y = 1.831x - 1.931</b>	<b>y = -0.01x + 14.59</b>

**Table 2. Temperature and RH data of Room and ZECC storage**

Days of storage	Room storage		ZECC	
	Temp (°C)	RH (%)	Temp (°C)	RH (%)
1	37.8	39	26.9	84
2	33.0	25	25.5	78
3	36.0	25	25.4	79
4	34.3	17	25.4	79
5	33.0	20	23.4	81



**Fig. 2. Effect of different storages on moisture (%) in guava fruits**

produce but also it also results in loss in appearance, taste and nutrients, leading to greater economic loss [17]. The higher relative humidity retains the moisture content of post-harvest sample. Because of water is an important factor in maintaining post-harvest quality [18]. Shrinkage in guava is depend on geometric dimension of guava which affected by temperature, relative humidity and type of storage conditions. Lowest shrinkage (Fig. 4) was reported in ZECC (0 to 6.54%), followed by Refrigeration (0 to 7.88%) and highest at room temperature (0 to 15.19%). It is clear that higher temperature and low humidity affect the dimension of fruits which responsible for shrinkage of the tissue during storage. Sensory parameter like colour of guava was observed by lightness meter at each day and noticed that

score of colour decreased with increasing the days of storage. Initial colour score was recorded for room storage (14.70), Refrigeration (15.95) and ZECC (15.60) whereas mean score for the last four days of storage as room storage (15.85), Refrigeration (14.52) and ZECC (14.30). The study revealed that the colour of the guava (Fig. 5) was increased in room storage as decreased in refrigeration and ZECC. Low temperature and high relative humidity decreased the colour intensity in guava while high temperature and low humidity increased color intensity Tables (1-2). From Table 1, It is clear that the lowest value of coefficient of determination was found best indication of lowest Physiological loss in weight in guava during storage in ZECC.

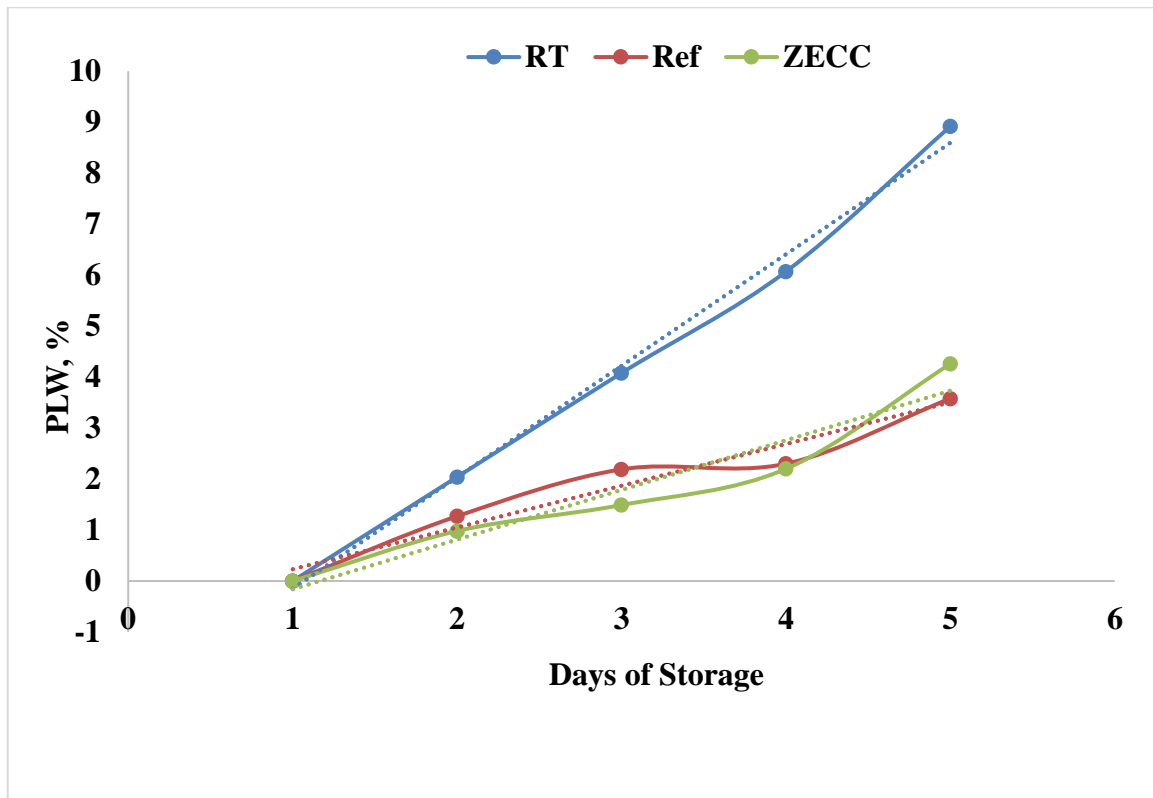


Fig. 3. Effect of different storages on physiological loss in weight (%) in guava fruits

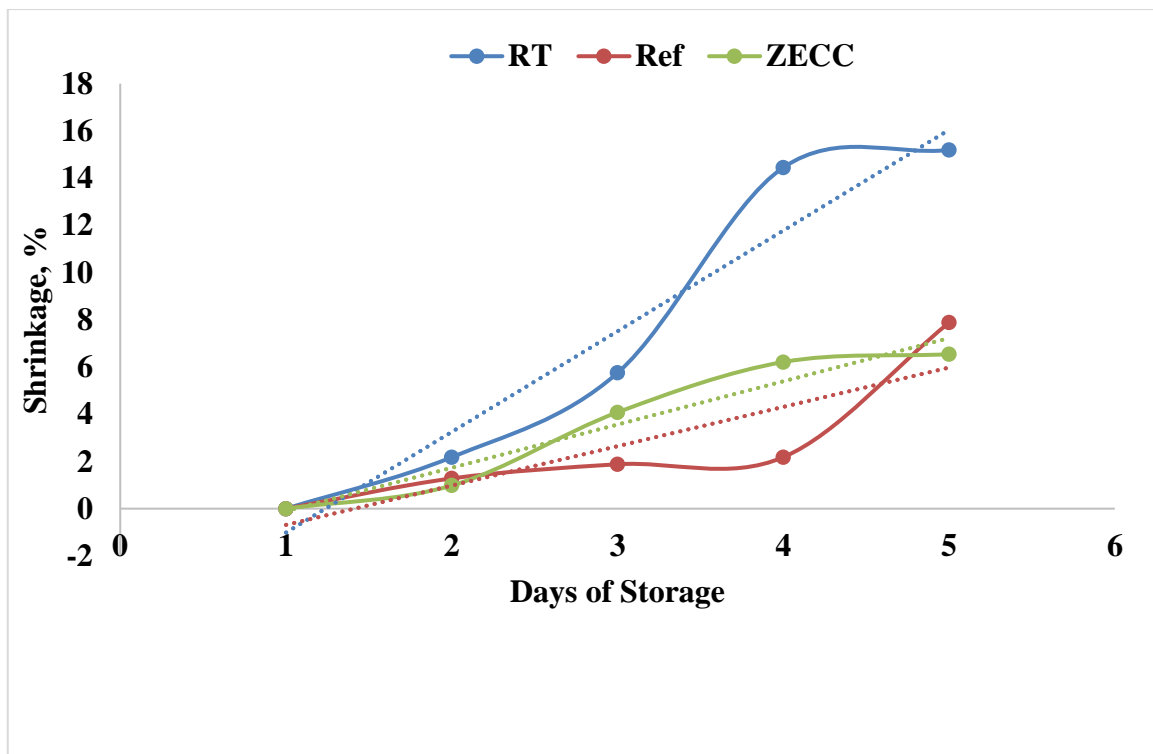


Fig. 4. Effect of different storages on shrinkage (%) in guava fruits

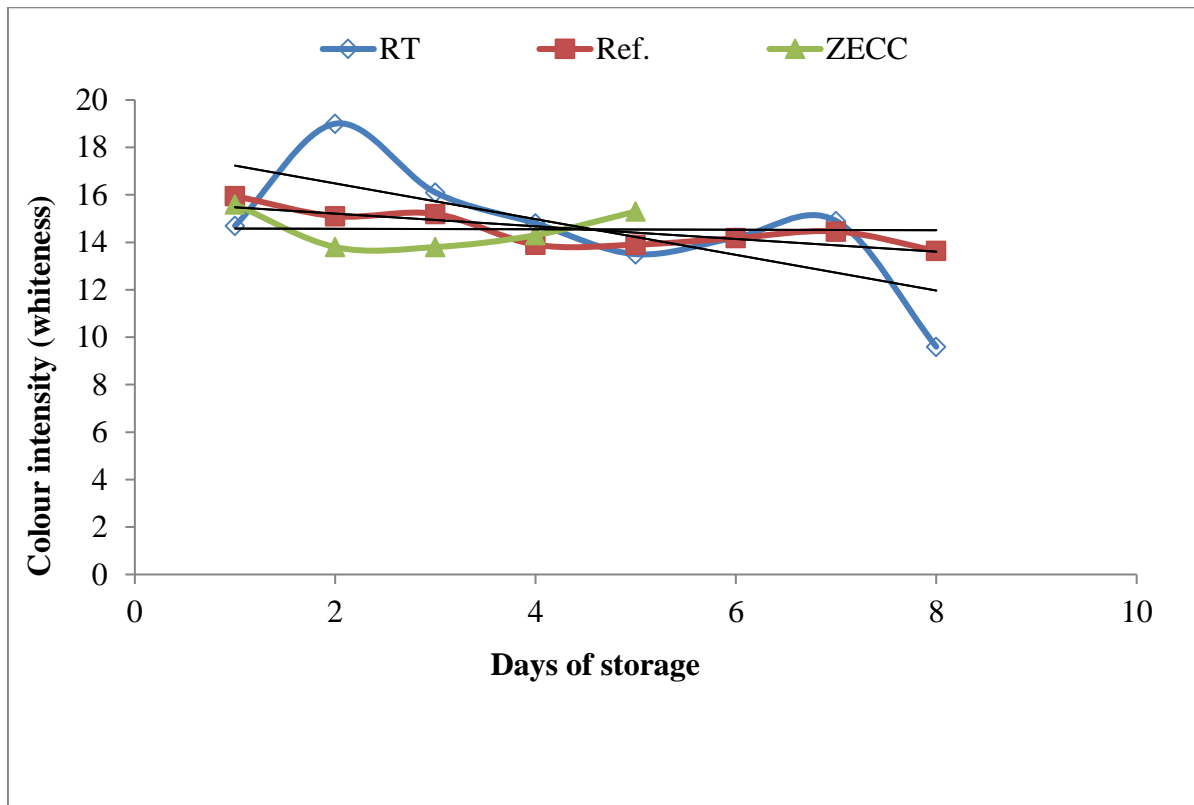


Fig. 5. Effect of different storage on the colour of the guava fruits

#### 4. CONCLUSION

The initial moisture content in Guava were evaluated 83.4% (502.40%, db). In case of Guava fruits, the moisture content and mass of guava was decreased while Physiological loss in weight (%) and shrinkage (%) was increased with increasing days of storage in all types of storage. Lowest decrement in PLW (0 to 4.26%) and shrinkage (0 to 6.54%) was observed in Zero energy cool chamber as compared to other storage condition. Freshness was calculated according the colour intensity (Whiteness) of fruits. Zero energy cool chambers (ZECC) are also observed the lowest rate of decrement in PLW and shrinkage. ZECC was found suitable for fruits of guava as per present study and some human errors also taken during experiments. Temperature was observed best suitable viz. 24.3 to 26.9 °C and RH 79 to 84% in ZECC as compared to ambient storage i.e. Temperature ranged 33.0 - 37.8°C and RH (17 - 39%).

#### 5. RECOMMENDATIONS

The evaporative cooled storage structure has proved to be useful for short term, on-farm

storage of fruits and vegetables in hot and dry regions. Evaporative cooling is an efficient and economical means for reducing temperature and increasing the relative humidity of an enclosure, and has been extensively tried for enhancing the shelf life of horticultural produce which is essential for maintaining the freshness of the commodities. Evaporative cooling is an environmentally friendly air conditioning system that operates using induced processes of heat and mass transfer where water and air are working fluids. Such a system provides an inexpensive, energy efficient, environmentally benign (not requiring ozone-damaging gas as in active systems) and potentially attractive cooling system. The semi-perishable fruit and vegetables, milk and some products, cooked food, mushroom, meat, fish, flowers and that have a short shelf life can be stored inside the zero-energy cool chamber.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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