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## Respiration and ethylene evolution behavior of sapota and their relationship to postharvest shelf life

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**Abstract**

Sapota (*Manilkara achras* Mill.) is an important tropical fruit belonging to family sapotaceae, and grown commercially in India. Fruit is mainly preferred for fresh market consumption, to lesser extent used to produce the jam or fresh juice. Due to the highly perishable nature of the fruit, it is necessary to identify the genotypes for better postharvest quality and shelf life. The study was carried out to evaluate the Kalipatti, Cricket Ball and Oblong varieties for postharvest respiration and ethylene evolution during storage at  $26 \pm 2$  °C for 8 days. Kalipatti variety showed significantly lower rate of respiration, ethylene production as compared to other two varieties. The study revealed that the kalipatti variety holds better promising results with lower respiration and ethylene productions which directly helps in extending the marketable life of fruits.

**Keywords:** Sapota, varieties, kalipatti, cricket ball, postharvest quality, storage

**1. Introduction**

Sapota (*Manilkara achras* Mill.) is a tropical fruit belongs to family sapotaceae was grown commercially in India. It is preferred in Indian market for its delicious, nutritive fruit valued for its mellow and sweet tasty pulp with sandy texture and pleasant aroma (Siddiqui *et al.*, 2014) [10]. India is the largest producer and exporter of Sapota fruit in the world with estimated production of 1.20 million metric tonnes from an area of 0.10 million hectare area (NHB, 2018) [7]. The fruit is mainly preferred for fresh market consumption, and to lesser extent used to produce the jam or fresh juice (Foo *et al.*, 2018) [5]. Major marketability constraints of sapota fruit was high respiration and ethylene production, high moisture and poor texture of the fruit.

Physiologically sapota is a climacteric fruit which shows respiratory climacteric ranging from 16 to 35 mL CO<sub>2</sub> kg<sup>-1</sup> h<sup>-1</sup> at 20°C (Arevalo Galarza *et al.* 1999; Yahia and Gutierrez-Orozco, 2011) [2,4] and ethylene production rate varies from 10 to 100 µL C<sub>2</sub>H<sub>4</sub> kg<sup>-1</sup> h<sup>-1</sup> (Alia-Tejacal *et al.* 2007; Kader, 2007) [1] making one of the highest ethylene producing fruit. Thus high perishability of sapota fruit occurs due to quick commodity ripening and senescence of fruit rendering it shelf-stable for 3-5 days at 25-27 °C and also sensitive to postharvest diseases may causes upto 25-30% postharvest loss of sapota have been reported by Salunkhe and Desai (1984) [9] and Siddiqui *et al.* (2014) [10]. Shelf life and postharvest quality of fruits also depends on the pre-harvest factors such as genotypes selection, cultural practices such as application of fertilizers, training, pruning, applications of plant growth regulators. So the selection of varieties is the basic step in successful production and marketing of fruits. Keeping the cited points in view, present investigation was conducted with an objective. Evaluation of three local sapota varieties for their postharvest respiration and ethylene production during the storage.

**2. Materials and Methods**

The experiment is carried out at Food Science and Postharvest Technology, ICAR-Indian Agricultural Research Institute, New Delhi during 2016-19. Sapota (*Manilkara achras* Mill.) varieties Kalipatti, Cricket Ball and Oblong fruits were harvested at commercial maturity stage were provided by ICAR-Indian Institute of Horticulture Research, Bangaluru, Karnataka (Plate 3.1). The harvested fruits were disinfected with 1% sodium hypochlorite and rinsed in clean water. The fruits were then artificially ripened in ripening chamber with the operating

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conditions (100 ppm C<sub>2</sub>H<sub>4</sub>, 24 hours, RH-95%, CO<sub>2</sub> <1%). The uniformly ripened fruits were further used for their postharvest evaluation.

## 2.2 Respiration rate

The respiration rate of sapota fruits were measured by using Respiratory Gas Analyzer (PBI Dansor, Denmark) at ambient conditions. For measuring respiration rate the selected fruits of different treatments were enclosed hermitically in a 1000 mL container for 2 hours at 20 °C storage temperatures and then the head space gas was measured by piercing the syringe into the container through the rubber septa fixed on the lid of container and values are recorded. The respiration rate was calculated using the following formula (Ong *et al.*, 2013) [8].

$$\text{Respiration Rate (mg of CO}_2\text{ /kg/h)} = \frac{\% \text{ CO}_2 \times \text{Head Space}}{\text{Fruit weight (g)} \times \text{Enclosure time (h)} \times 100}$$

## 2.3 Ethylene evolution rate

**Calibration of gas chromatograph (GC):** A Hewlett Packard (H.P.) gas chromatograph (5890 Series II) equipped with a flame ionization detector (FID), Porapack-N 80/100 mesh packed stainless steel column and a H.P. integrator was used for determination of ethylene. The temperature of injector, column and detector were adjusted to 110 °C, 60 °C and 275 °C and the flow rate of nitrogen, hydrogen and air were maintained as 30, 30 and 300 mL/minute, respectively. Some amount of ethylene was collected into a fraction collector from standard calibration gas of ethylene (EDT research, London, U.K.). One ml of standard ethylene was drawn from fraction collector using Hamilton gas tight micro syringe and injected into the G.C. The integrator was calibrated by recording retention time and peak area of the standard ethylene gas.

**Sample preparation:** Three fruits from each replication were marked for determination of ethylene evolution. Once the chromatograph was standardized and calibrated, one mL gas sample was drawn through the sub seal septum with the help of a gas tight micro syringe after a specified time of trapping of fruit (3 h). The sample was injected into the GC and concentration of evolved ethylene (ppm) within the time interval was recorded from the integrator. The rate of ethylene evolution was expressed as  $\mu\text{L /kg/h}$ .

$$\text{Ethylene rate } (\mu\text{L C}_2\text{H}_4\text{/kg/h)} = \frac{\text{C}_2\text{H}_4 \text{ } (\mu\text{L/L)} \times \text{Volume (ml)}}{\text{weight (kg)} \times \text{time (h)}}$$

## 2.4 Statistical analysis

The experiment was laid out in a completely randomized design with 4 replications. The results were subjected to analysis of variance (ANOVA) and the treatment means were compared using the least significant difference (LSD) values at a significance level of <0.05. All analyses were conducted using SPSS Statistics 17.0 (IBM, New York, New York, USA).

## 3. Results and Discussion

### 3.1 Respiration rate

The respiration rate of sapota varieties clearly indicates lower rate of CO<sub>2</sub> production during initial days and subsequent increase in respiration upto 4<sup>th</sup> day was observed. Initially the respiration rate was 46.23, 49.51 and 50.10 mL CO<sub>2</sub> /kg/h in case of kalipatti, cricket ball and oblong respectively. The respiratory peak was observed on 4<sup>th</sup> day with respiration rate of kalipatti (69.89 mL CO<sub>2</sub> /kg/h), cricket ball (74.67 mL CO<sub>2</sub> /kg/h) and 78.78 mL CO<sub>2</sub> /kg/h in case of oblong (Figure 1). The respiration rate was significantly lesser in case of kalipatti variety of sapota as compared to other two varieties. Rate of change in respiration rate in case of kalipatti, cricket ball and oblong variety during the 8 days storage period was 6.913%, 7.513% and 8.011% respectively. Respiration rate was positively correlated with the titratable acidity, ascorbic acid, ethylene evolution and negatively correlated with total soluble solids in all the three varieties during the storage period of 8 days. Our findings are in consonance with Bhutia *et al.* (2011) [3]; Moo-Huchin *et al.* (2013) [6]. Bhutia *et al.* (2011) [3] reported that the respiration rate of sapota cv. kalipatti as (72.0 mL CO<sub>2</sub> /kg/h) on 3<sup>rd</sup> day of storage.



Plate 2.1: Fruits of sapota varieties kalipatti, cricket ball and oblong

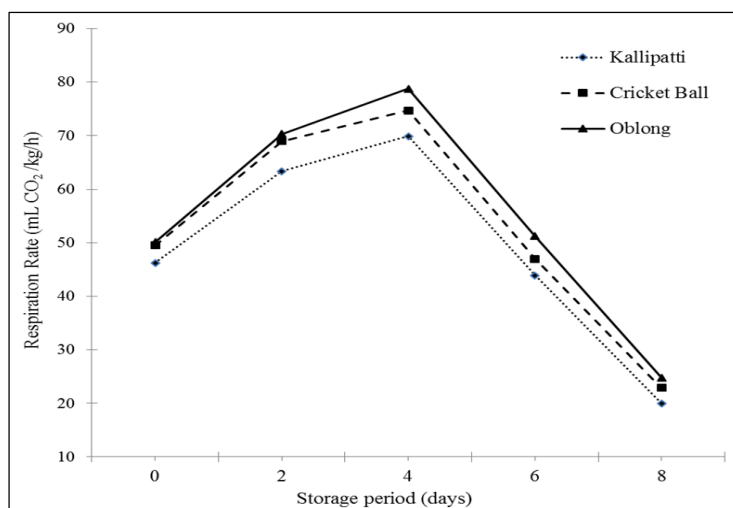


Fig 1: Respiration Rate ( $\mu\text{L C}_2\text{H}_4\text{/kg/h}$ ) for sapota varieties during storage at  $26 \pm 2$  °C

### 3.2 Ethylene evolution rate

The results revealed that peak ethylene production was observed on 4th day of storage. Ethylene evolution was reported to be 189.32  $\mu\text{L C}_2\text{H}_4/\text{kg/h}$  kalipatti, for cricket ball (215.13  $\mu\text{L C}_2\text{H}_4/\text{kg/h}$ ) and 225.50  $\mu\text{L C}_2\text{H}_4/\text{kg/h}$  in case of oblong variety (Figure 2). The lower ethylene production was observed in case of kalipatti variety of sapota compared to

cricket ball and oblong throughout the storage period. Rate of change in ethylene evolution for kalipatti, cricket ball and oblong variety during the 8 days storage period was 18.52%, 21.64% and 22.56% respectively. Ethylene evolution has positive correlation with total soluble solids and negative correlation with titratable acidity, ascorbic acid. Our findings are well agreed with the reports of Bhutia *et al.*, 2011<sup>[3]</sup>.

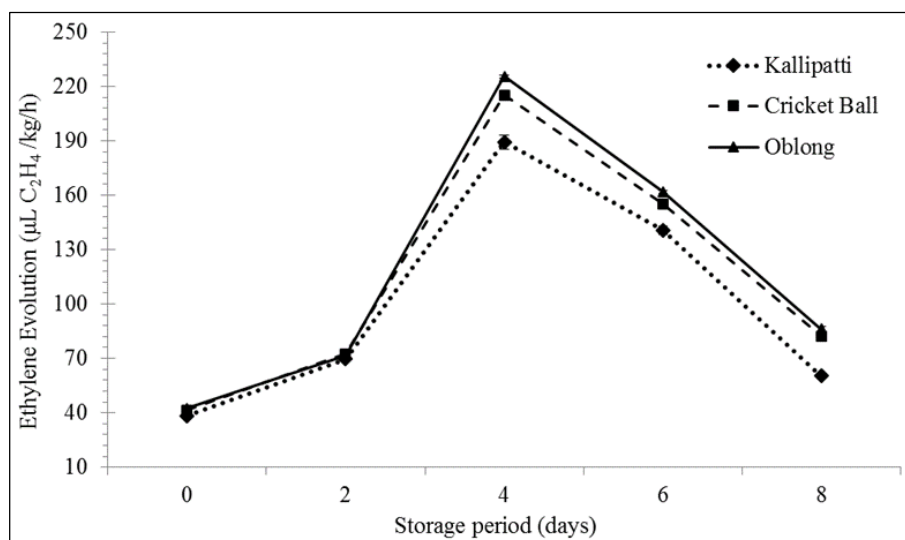


Fig 2: Ethylene evolution rate ( $\mu\text{L C}_2\text{H}_4/\text{kg/h}$ ) for sapota varieties during storage at  $26\pm 2\text{ }^\circ\text{C}$

### 3.3 Correlation study

Ethylene production in sapota fruit was significantly positively correlated with the respiration rate. Respiration and ethylene are showed the positive correlation with correlation value of 0.517. Figure 1 shows that the respiratory peak begins first followed by ethylene sharp peak. This indicates that with the increased respiration rate there is concomitant increase in ethylene production was takes place.

### 4. Conclusions

Sapota is a tropical fruit especially grown for fresh market. The present investigation demonstrated that the fruit quality is governed by different varieties of sapota. It was clearly evident that the fruit from the variety kalipatti was significantly superior in terms of respiration and ethylene evolution parameters followed by cricket ball and oblong. Kalipatti variety has showed significantly lower respiration and ethylene evolution as compared to other two varieties. The study revealed that the kalipatti variety will be the better option in terms of postharvest shelf life of sapota fruits during storage. Hence, it will emerge as a good option for growers to grow this variety for mass production and export.

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