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RESPIRATORY BEHAVIOUR OF MATURE LIGHT GREEN GUAVA (*Psidium guajava L.*) UNDER CLOSED SYSTEM

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Abstract: Respiratory behavior is an important aspect in designing and operating systems such as controlled and modified atmosphere storage that will extend the shelf life of the perishable produce. The respiration rate and respiratory quotient of fresh Guava (*Psidium guajava* L. cv. 'Safeda') fruit harvested at the mature light-green stage were determined under closed system at 5, 10, 15, 20, 25 and 35°C (ambient) temperatures. The respiration rate based on carbon dioxide production in aerobic condition decreased about 46% relative to air atmosphere. However the oxygen consumption sharply reduced to 31% relative to air atmosphere at 25°C temperature. The results suggest that, the respiration rate of Guava increased with temperature and decrease with storage time. Results of the study can be applied to design suitable packaging system for shelf life extension of Guava.

Keywords: *Guava fruit, physic-chemical properties, respiration rate, respiratory quotient.*

INTRODUCTION

Guava (*Psidium guajava* L.) is a commercially important fruit crop in Brazil, Mexico, India and many other tropical countries. Short postharvest life, high susceptibility to chilling, mechanical damage and pathogens limit its distribution to the domestic markets [2]. The significance of respiration in extending the shelf-life of fresh fruits and vegetables stems from the fact that there exists an inverse relationship between respiration rate and the shelf-life of the commodity [3]. Respiration rate, which is

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commonly expressed as rate of O_2 consumption and/or CO_2 production per unit weight of the commodity, reflects the metabolic activity of the fruit tissue in the form of biochemical changes associated with ripening [4]. Another important parameter associated with respiration is the respiration quotient (RQ). Very high values of the RQ or a sudden shift in RQ value indicate a shift in the respiration cycle to the anaerobic cycle [7]. This helps select appropriate packaging materials when designing modified atmosphere (MA) packaging systems [8], identifying the vital heat in calculation of refrigeration load, select fan size and location for optimal air flow within controlled atmosphere (CA) facilities and formulate appropriate process control for ventilating storage facilities [6]. Thus, the accurate measurement of respiration is an important step in the successful design storage system for horticultural produce like Guava. Keeping in view the above, it is proposed to study the respiratory behavior of green mature Guava 'Safeda' cultivar under closed system at different temperatures.

MATERIALS AND METHODS

Fruit Materials

Guava (*Psidium guajava* L. cv. 'Safeda') fruit harvested at the mature light-green stage from fruit farm of Central Institute of Agricultural Engineering, Nabi-Bagh, Berasia Road, Bhopal for experimentation and study. The Guavas were graded manually to remove damaged, infested and non-uniform fruit. Fruits were selected to insure uniform size, shape and weight for further experimentation

The parameters such as sphericity, fruit volume, true density, were determined objectively in the lab for mature green Guava before start of the respiration rate study as per the method adopted by [9] and [5].

Measurement of rates of respiration

The respiration rate measurement of Guava was done as per the method adopted by [9]. A closed system is used to measure the respiration rate of the green mature Guava (Fig 1). A known weight (1kg) of green mature Guava was filled into air tight glass container of known volume. The container was sealed carefully using vacuum grease. A single hole covered with silicon septum was made in container for measurement of gas concentrations. After packaging, container was kept at different temperature i.e. 5°C, 10°C, 15°C, 20°C, 25°C and 35°C (ambient temperature) at 75% RH in an Environment System (Systec instruments, Draihan LabTech Co. Ltd, UK; Model: GS3/P-898C) and time was recorded (Fig 1).

Respiration rates in terms of O_2 consumption and CO_2 evolution and respiratory quotient (*RQ*) were determined according to the equations (1) and (2) below:

$$R_{O_2} = \frac{(p_{O_2}{}^{in} - p_{O_2}{}^{f})V_V}{100 \times W \times (t^f - t^{in})} \quad \text{and} \quad R_{CO_2} = \frac{(p_{CO_2}{}^{f} - p_{CO_2}{}^{in})V_V}{100 \times W \times (t^f - t^{in})} \tag{1}$$

where:

P_{O2} [%] - partial pressure of oxygen gas,

P_{CO2} [%] - partial pressure of carbon-dioxide gas,
V_v [ml]- void volume,
W [kg]- weight of the sample,
t [h] - time,
in [-] - “initial”,
f [-] - “final”.

$$RQ = R_{CO_2} \cdot R_{O_2}^{-1} \tag{2}$$

where:

RQ	[-]	- respiratory quotient,
R_{O2}	[ml·kg^{-1}·h^{-1}]	- respiration rate of oxygen gas,
R_{CO2}	[ml·kg^{-1}·h^{-1}]	- respiration rate of carbon-dioxide gas.

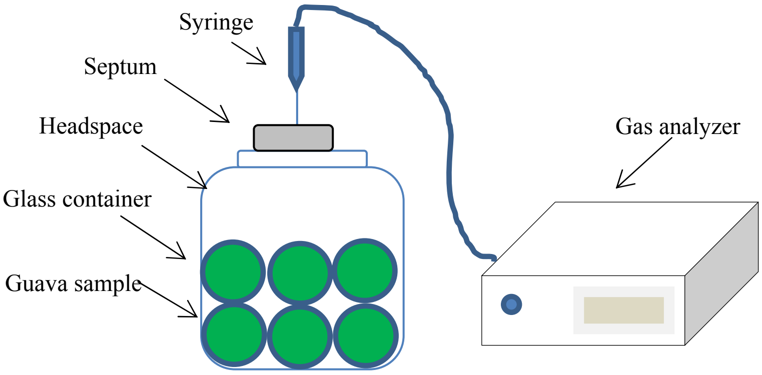


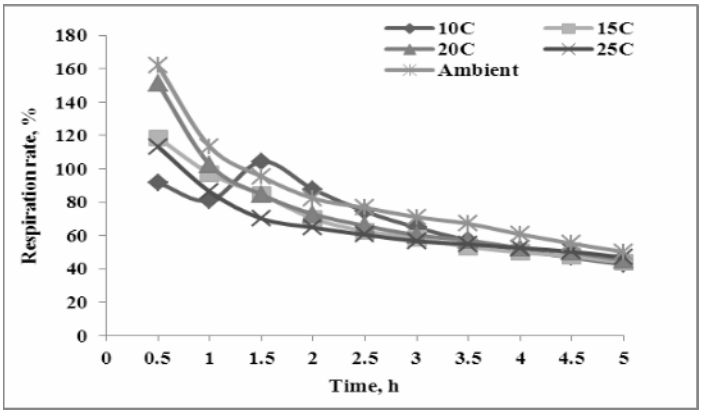
Figure 1. A closed system for respiration rate measurement of the mature light green Guava

RESULTS AND DISCUSSION

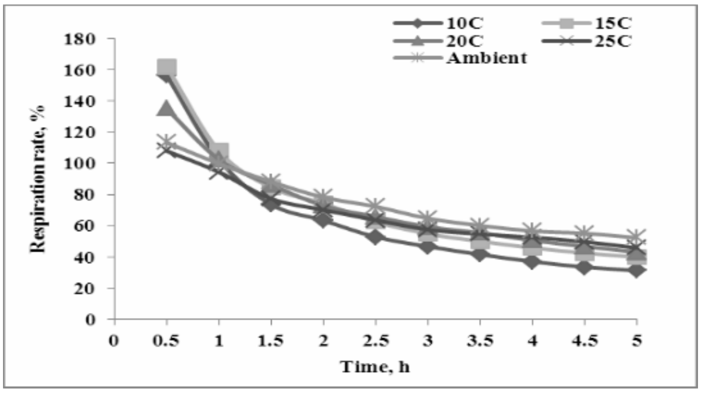
Rate of respiration

The respiration data corresponding to the different temperature indicated that as the temperature increased the respiration progressed at a faster rate. The rate of respiration gradually increased and was higher at the start of the experiment and gradually declined as the storage period prolonged, before becoming almost constant (Fig. 2). The steady-state respiration rate for O_2 consumption was observed to be 31.32, 39.96, 43.20, 45.90 and 52.38 ml·kg^{-1}·h^{-1} at 10°C, 15°C, 20°C, 25°C and 35°C (ambient), respectively. Similarly the steady-state respiration rate for CO_2 evolution were observed to be 42.66, 43.74, 45.36, 46.90 and 50.22 ml·kg^{-1}·h^{-1} at 10°C, 15°C, 20°C, 25°C and 35°C (ambient), respectively. For similar temperature increments, the increase in respiration rate was 2.53, 6.32, 9.93 and 17.72 degree folds for O_2 and 27.58, 37.93, 46.55 and 67.24 degree folds for CO_2 evolution respectively at 15°C, 20°C, 25°C and 35°C (ambient) temperatures.

At all temperatures, the CO_2 consumption rate remained higher than the O_2 evolution rate giving steady-state respiration quotient between 0.7 to 1.70 (Fig 3).



a.



b.

Figure 2. Respiration rate of O_2 depletion (a) and CO_2 evolution (b) for mature lightgreen guava (Safeda) at 5, 10, 15, 20, 25 and 35°C (ambient) temperatures

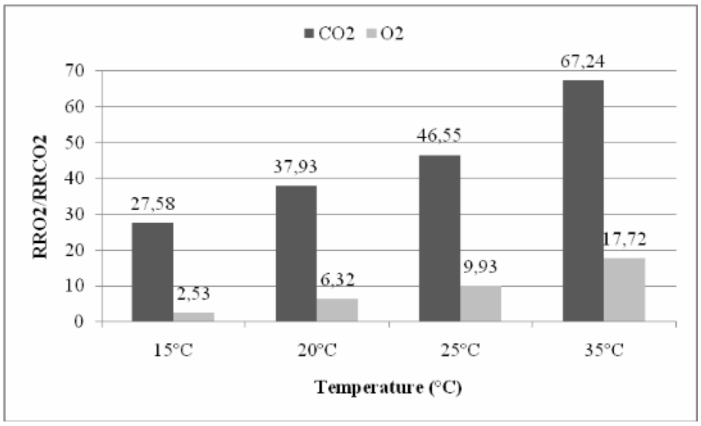


Figure 3. Degree-fold increase in $RRO_2/RRCO_2$ of mature light green guava cv. (Safeda) at different temperature increments

The respiration rate RRO_2 and $RRCO_2$ at all temperature increments observed in this study is in agreement with the respiration range suggested by [5, 8, 9] which is about 42-45 ml $CO_2 \cdot kg^{-1}h^{-1}$. It should be noted that, these values of RO_2 and RCO_2 during respiration rate that were, as previously mentioned, calculated by using normal air rather than using the gas concentration values of modified atmosphere and for the reason, they are more than the respiration rate in previously modified atmosphere under identical temperature.

Respiratory quotient

The ratio of carbon dioxide generation to oxygen consumption will be close to unity when substrate used in the metabolic process is carbohydrate and sufficient amount of oxygen is available. Respiratory quotient (*RQ*) depicts the ratio of the volume of carbon dioxide released to the volume of oxygen consumed by a body tissue of fruit in a given period [1]. The respiratory quotient exhibited minor fluctuations during the initial stage of respiration rate experiments. The respiratory quotient stabilized as the experiment achieved steady state condition. It was observed that, the *RQ* indicated gradual decline at 10 and 15°C temperature in the early stage of experimentation. However, at 20, 25°C and 30°C temperatures, fluctuation observed in *RQ* was very low. These resulted phenomena may be due to the fact that at lower temperature reduces the metabolic activity consequently results in decreasing respiration rate. It was observed that higher temperature enhances the respiration rate and substrate (O_2) is dissolved at a faster rate resulting in production of more CO_2 leading to a faster accumulation of more CO_2 within the closed system and causing an increase in the respiratory quotient even at the early stage of experiment.

At a given temperature condition, RQ was found varying between 1.7 to 0.7 with the time under aerobic condition. *RQ* is less than unity; the O_2 consumption was always higher than the oxidative CO_2 production. This corresponds to some other fresh produce reported by [2, 4, 10, 11, 12]. A change in the respiratory quotient at different temperature was shown in Fig 4.

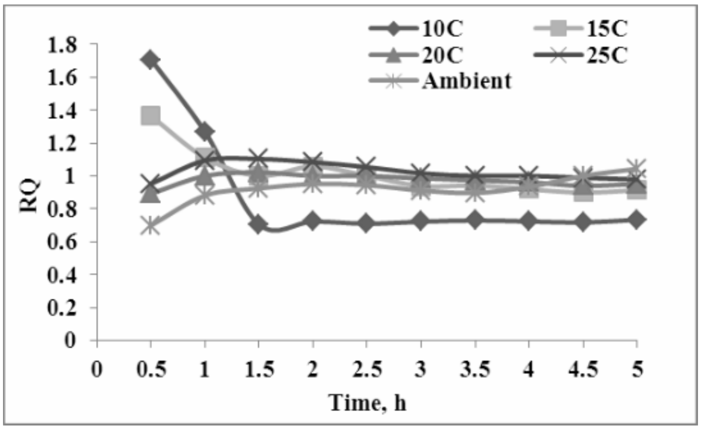


Figure 4. Respiratory quotient (RQ) of Guava at different temperature

CONCLUSIONS

Based on the experiments, it was concluded that the steady-state respiration rates were found to be decreasing with storage time. The respiration rates were also found to be increasing with increasing storage temperature. At all temperatures, the O_2 consumption rate remained higher than the CO_2 evolution rate giving steady-state respiration quotient values between 0.7-1.7 at different temperatures. After 2 hours of storage period, *RQ* was found slightly varying with the time under aerobic condition.

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RESPIRATORNO PONAŠANJE ZRELE SVETLO ZELENE GUAVE (*Psidium guajava L.*) U ZATVORENOM SISTEMU

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Sažetak: Respiratorno ponašanje je važan aspekt u projektovanju i rukovanju sistemima kao što je kontrolisana i modifikovana atmosfera skladišta koja će produžiti period skladištenja. Stepen respiracije i koeficijent respiracije sveže guave (*Psidium guajava L.* cv. 'Safeda'), ubrane u zreloj svetlo-zelenoj fazi, određeni su u zatvorenom sistemu pri ambijentalnim temperaturama od 5, 10, 15, 20, 25, 30 i 35°C. Stepen respiracije zasnovan na proizvodnji ugljendioksida u aerobnim uslovima opao je za 46% u odnosu na atmosverski vazduh. Potrošnja kiseonika se značajno smanjila na 31% u odnosu na atmosverski vazduh pri temperaturi od 25°C. Dobijeni rezultati upućuju na zaključak da se stepen respiracije guave povećava sa povećanjem temperature, a smanjuje sa produženjem vremena skladištenja. Rezultati ovih istraživanja mogu se primeniti pri projektovanju optimalnih sistema za pakovanje kojima bi se produžio period skladištenja guave.

Ključne reči: *guava, fizičko-hemijske osobine, stepen respiracije, koeficijent respiracije*

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