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RESEARCH PAPER

Effect of product free volume ratios on the respiration rate of tuberose (*Polianthes tuberosa*) flowers

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SUMMARY : The experiment was carried out to study the effect of product free volume ratios on the respiration rate of tuberose (*polianthes tuberosa*) flowers under different storage condition. Tuberose flowers were selected for the study, based on their growing export demand. Known quantities (25g, 50g and 100g) of flowers were kept in the closed system under air tight condition in the PET container containing ambient air as the initial atmosphere. Then respiration rate of the flowers was measured with respect to different time and temperature conditions. (ambient conditions 25-27°C and refrigerated 6-8°C conditions). From respiration studies it was concluded that, as the product free volume ratio decreases the rate of O_2 consumption was accelerated. Also the respiration rate of the tuberose flowers stored under ambient condition was 0.21 to 0.28 m^3/kg-h for O_2 and 0.19 to 0.30 m^3/kg-h for CO_2 and under refrigerated condition were 0.013 to 0.022 m3/kg-h for O_2 and 0.010 to 0.014 m^3/kg-h for CO_2. Respiration rate of the flowers under ambient condition was greater than the flowers stored under refrigeration condition due to the slow metabolic activities.

Key Words : Respiration rated, Post harvest handling of tuberose, Selflife of tuberose

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Tuberose (*Polianthes tuberosa* L.) is a bulbous ornamental flower. In India it is cultivated for its fragrant (Naidu and Reid, 1989). It consists of 'Single', 'Semi double' and 'Double' type of flowers which are popular both in domestic and export markets.

Respiration can be defined as the metabolic process that provides energy for plant biochemical processes. It involves oxidative breakdown of organic reserves to simpler molecules, including CO_2 and water, with the release of energy. The significance of respiration in extending the shelf-life of fresh fruits, vegetables and flowers that there exists an inverse relationship between respiration rate and the shelf life of the commodity. Respiration rate of the produce gives an advanced insight into the respiratory kinetics of the storage system and also helps to predict the respiratory quotient. This helps to select appropriate packaging materials when designing modified atmosphere (MA) packaging system (Ravindra and Goswami, 2008). Thus, the accurate rate of respiration kinetics is an important step in the successful design and operation of storage techniques for horticultural produce.

Hence, the focus of the present study was to determine the respiration rate of flowers and also study the effect of product free volume ratios on the respiration rate of tuberose flowers under different storage conditions

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EXPERIMENTAL METHODS

The experiment was conducted at Department of Food and Agricultural Process Engineering, coimbatore during 2010-2011.

Fresh flowers of tuberose (*Polianthes tuberosa*) species

were procured from M/s. Vanguard Exports (Private firm exporting Jasmine and Tuberose flowers) located at flower market in Coimbatore during the entire period of study. The respiration rate of the flowers was measured by the closed or static system containing ambient air as the initial atmosphere with respect to different time and temperature conditions (Devlieghere *et al.,* 1999). *i.e.* at ambient (25-27°C) and refrigerated (6-8°C) conditions. Uniformly sorted known quantities of 25g, 50g and 100g of flowers were kept in the closed system under air tight condition in the PET container. The container was fitted with a silicon septum (for sampling of gases) containing ambient air as the initial atmosphere. Gas samples were drawn from the container through silicon rubber septum using needle for every three hour intervals and O_2 - CO_2 concentration inside the container was measured using O_2 - CO_2 analyzer (PBI Dansensor, Denmark). The experimental setup is shown in Fig. A.

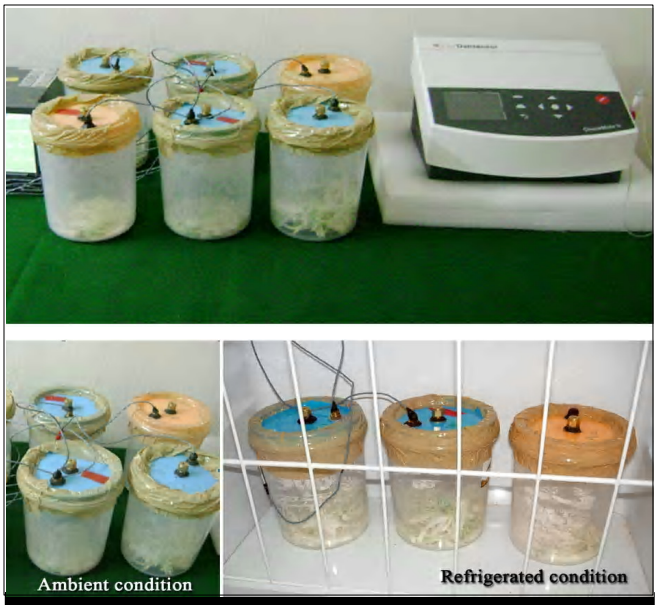


Fig. A : Experimental setup

The respiration rate can be calculated by change in oxygen concentration with time when the commodity was stored in a closed container as given below (Cameron *et al.,* 1989).

$$RCO_2 = \frac{(Y_{ti}\,CO_2 - Y_{tf}\,CO_2) \times V}{100 \times M \times (t_f - t_i)} \quad (1)$$

$$RCO_2 = \frac{(Y_{ti}\,CO_2 - Y_{tf}\,CO_2) \times V}{100 \times M \times (t_f - t_i)} \quad (2)$$

where,

M- Mass, kg

V- Free volume, m^3

t_i, t_f - Initial and final time, s

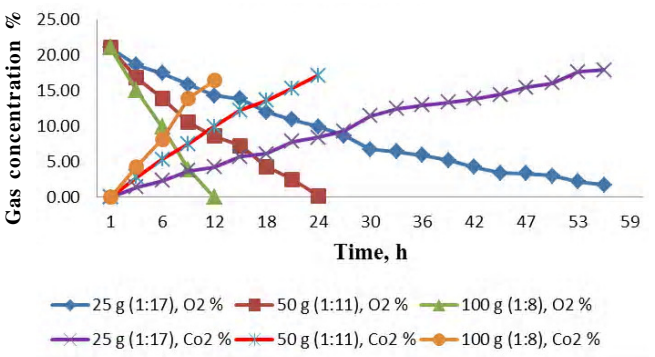
RO_2 and RCO_2 - Respiration rate of oxygen and carbon dioxide, m^3/ kg s

$Y_{ti}O_2$ and $Y_{tf}O_2$ – Initial and final concentration of oxygen, m^3/ kg s

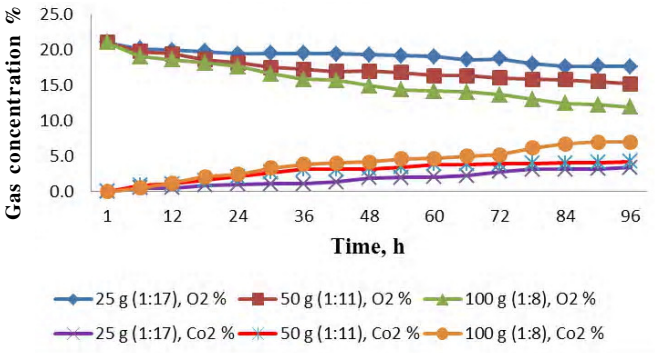
$Y_{ti}CO_2$ and $Y_{tf}CO_2$– Initial and final concentration of carbon dioxide, m^3/ kg s.

EXPERIMENTAL FINDINGS AND ANALYSIS

The effect of product free volume ratios on the respiration rate of tuberose flowers under ambient and refrigeration conditions designed. It was observed from Fig. 1, that flowers stored under ambient condition for 25 g (product free volume ratio, 1:17), the percentage of O_2 absorbed and CO_2 evolved, after 56 hours of storage reached zero and 18 per cent, respectively (Fig. 1a). For 50 g (product free volume ratio, 1: 11) of flowers, time taken was 24 hours to reach the zero level of O_2 concentration, where CO_2 concentration was noted as 17.1 per cent. Similarly, 100 g (product free volume ratio, 1:8) of flowers, time taken was 12 hours to reach the zero level of O_2 concentration and at this point the CO_2 gas concentration was recorded 17 per cent. From the above result it can be concluded that, as the product free volume ratio decreases (product weight increases) the rate of O_2 consumption was accelerated.



(a) Ambient condition



(b) Refrigerated condition

Fig. 1 : Effect of product free volume ratio of tuberose flower in respirometer on gas composition

Table 1 : Regression equation for O_2 consumption CO_2 evolution rate of tuberose flowers for different product free volume ratio

Product free volume ratio	Gas concentration	Equation	R^2
25 g (Ambient temperature)	O_2	$y = 0.0042x^2 - 0.5732x + 20.849$	0.9962
(product free volume ratio,1:17)	CO_2	$y = -0.0017x^2 + 0.4138x - 0.1646$	0.995
50 g (Ambient temperature)	O_2	$y = 0.0173x^2 - 1.2681x + 21.217$	0.9886
(product free volume ratio, 1:11)	CO_2	$y = -0.0131x^2 + 1.0452x - 0.6348$	0.9972
100 g (Ambient temperature)	O_2	$y = 0.0664x^2 - 2.7405x + 23.343$	0.9967
(product free volume ratio, 1:8)	CO_2	$y = -0.0922x^2 + 2.5164x - 2.5636$	0.9787
25 g (Refrigerated temperature)	O_2	$y = -0.075x^2 - 0.0228x + 20.397$	0.9203
(product free volume ratio,1:17)	CO_2	$y = 0.0003x^2 + 0.0159x + 0.2429$	0.9487
50 g (Refrigerated temperature)	O_2	$y = 0.0006x^2 - 0.105x + 20.519$	0.973
(product free volume ratio, 1:11)	CO_2	$y = -0.0007x^2 + 0.1028x + 0.0855$	0.9526
100 g(Refrigerated temperature)	O_2	$y = 0.0005x^2 - 0.1372x + 20.394$	0.9861
(product free volume ratio, 1:8)	CO_2	$y = -0.0003x^2 + 0.1002x + 0.1289$	0.9806

X-Time (hours), Y-Gas concentration (%)

Similarly under refrigerated condition from Fig. 1b, it is observed that for 25 g (product free volume ratio, 1:17) of flowers, the percentage of O_2 absorbed reached 17.6 per cent and further there was no significant difference in the successive readings and at this point CO_2 evolved was 3.4 per cent after 96 hours of storage. For 50 g (product free volume ratio, 1: 11) and 100 g (product free volume ratio, 1: 8) of tuberose flowers, after 96 hours the O_2 consumption was found to be minimum of 15.2 and 11.9 per cent, respectively, whereas CO_2 evolved at this point for 50 g (product free volume ratio, 1: 11) and 100g (product free volume ratio, 1: 8) of tuberose flowers were 4.2 and 7 per cent, respectively. From the above results it can be concluded that in refrigerated condition the O_2 consumption and CO_2 evolution activity was minimum due to the slow metabolic activities.

The respiration rate of the tuberose flowers stored under ambient condition was in the range of 0.21 to 0.28 m^3/kg-h for O_2 and 0.19 to 0.30 m^3/kg-h for CO_2 irrespective product free volume flowers taken and it was 0.013 to 0.022 m3/kg-h for O_2 and 0.010 to 0.014 m^3/kg-h for CO_2 for the flowers stored under refrigeration condition. From the above result it was came to know that the respiration rate of the flowers was higher in case of ambient condition compared with the refrigeration condition. The multiple regression equations were fitted relating the independent and dependent variables for different product free volume ratio and presented in Table 1.

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