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Effect of Storage Temperature on Respiration Rate of Aggregate Onion (*Allium cepa L Var aggregatum* Don.)

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An experiment was conducted to determine the effect of storage temperature on respiration rate of aggregate onion kept in closed PET containers with a product free volume ratio of 1:9 in two different storage conditions *viz.,* ambient (28˚C) and refrigerated (5˚C). The average respiration rate in terms of O_2 consumption and CO_2 evolution under ambient condition was 30.15 and 25.02 and under refrigerated condition was 5.85 and 2.83 ml/kgh, respectively. The average RQ values of ambient and refrigerated stored onion was 0.83 and 0.51, respectively leading to conclude that respiration rate of onion both in terms of O_2 consumption and CO_2 evolution increased with increase in storage temperature.

Key words: Aggregate onion, respiration rate, storage condition.

Onion (*Allium cepa L var aggregatum* Don.) is one of the oldest bulb crops known to mankind and consumed in Southern India. It contributes significant nutritional value to the human diet and have medicinal properties and are primarily consumed for their unique flavour or for their ability to enhance the flavour of other foods because of the presence of volatile compound known as allyl-propyl disulphide (Randle, 2000). Respiration is considered as a catabolic process, involving consumption of oxygen for oxidative breakdown of starch, sugars, fats, proteins, organic acids to simpler molecules such as carbon di oxide and water along with concurrent production of energy. Living cells of harvested plant products respire continuously, utilizing oxygen (O_2) from the surrounding environment and releasing carbon dioxide (CO_2). Fruit respiration is affected by temperature and oxygen partial pressure exerts strong effects (Fonseca *et al.,* 2002). Determination of respiration rate is useful as changes in respiration rate may indicate the stage of ripening in climacteric fruit. A continuously high rate of respiration is often associated with a shortened shelf life. Lower temperatures and altered gas concentrations reduce respiration and increase storage life of the product (Bhande *et al.,* 2008). Respiration Quotient (RQ) is the ratio of CO_2 produced to O_2 consumed during the respiration cycle. A very high value of the RQ or a sudden shift in RQ value indicates a shift in the respiratory cycle to anaerobic cycle (Saltveit, 2004). This suggests that it may be possible to use respiration rate to indicate the effectiveness of a set of storage conditions in prolonging storage life.

Materials and Methods

The present investigation was carried out between August and December, 2012 in Department of Food and Agricultural Process Engineering, Tamil Nadu Agricultural University, Coimbatore. Cured onion sample was selected and kept in air tight PET container with product to free volume ratio of 1:9. Schematic view of experimental setup for respiration studies are shown in Figs 1. & 2.

The containers were then stored in two different conditions *viz.,* ambient (28 ± 2˚C at 70% RH) and refrigerated conditions (5 ± 2˚C at 95% RH (if temp is low RH is high)). At every six hours interval, gas composition inside the containers was analysed using a gas analyzer (Make: PBI Dansensor Model: Checkmate II). The temperature inside the containers and the ambient were recorded through temperature indicator and hygrometer (Make: Equinox, Model: EQ-615).

Measurement of respiration rate

The respiration rate can be calculated by measuring change in O_2 or CO_2 concentration with time when the commodity was stored in a closed container as given below (Dilley and Dewey, 1969 and Cameron *et al*., 1989).

$$Ro_2 = \frac{\left(yo_2^{ti} - yo_2^{tf}\right) \times V}{100 \times M \times \left(t_f - t_i\right)}$$

$$Rco_2 = \frac{\left(yco_2^{tf} - yco_2^{ti}\right) \times V}{100 \times M \times \left(t_f - t_i\right)}$$

Ro_2 and Rco_2 are respiration rate in terms of O_2 consumed and CO_2 evolved in ml/kgh, respectively. V is the free volume (head space available *i.e* bulk density of aggregate onion is 563 kg/m^3) inside the container in ml. yo_2^{ti} and yo_2^{tf} are volumetric

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concentration of O_2 at initial and final stages, respectively in %. yco_2^{ti} and yco_2^{tf} are volumetric concentration of CO_2 at initial and final stages, respectively in %. M is the mass of the product in kg and t_i, t_f is initial and final time, respectively in h.

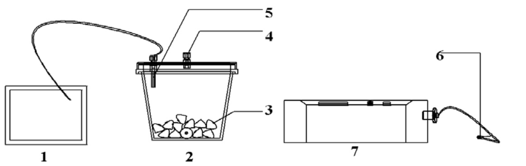
Results and Discussion

During respiration, O_2 level decreases and CO_2 level increases. Change in O_2 and CO_2 level is high and quick under ambient condition (Fig. 3) and low and slow in refrigerated condition (Fig. 4).

Fig. 1. Experimental setup for respiration rate measurement

Respiration rate in terms of O_2 consumption (ml/kg h)

Respiration rate measured in terms of O_2 consumption was observed (Fig. 5) as maximum of 48.77 ml/kgh after 6th h followed by 40.73 ml/kgh



1. Temperature indicator 2. Container (PET) 3.Sample (Onion)
4.Thermocouple Probe 5.Gas sampling Port 6. Needle 7. Gas analyzer.

Fig. 2. Schematic diagram of experimental setup for respiration studies

after 12th h under ambient condition and 8.57 ml/kgh after 6th and 48th h followed by 8.04 ml/kgh after 30th h under refrigerated condition. The minimum O_2

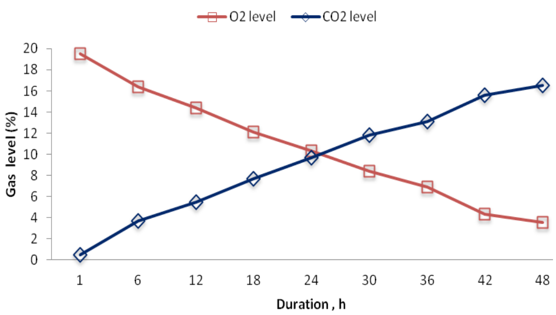


Fig. 3. Change of O_2 and Co_2 level under ambient condition

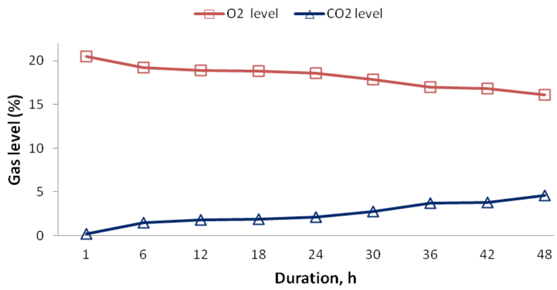


Fig. 4. Change of O_2 and Co_2 level under refrigerated condition

consumption was observed as 12.59 ml/kgh after 30th h followed by 20.36 ml/kgh after 48th h under ambient condition and 3.21 ml/kgh after 12th h followed by 4.28

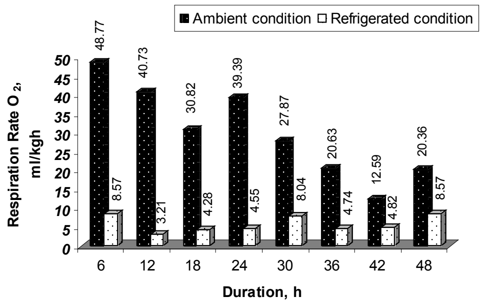


Fig. 5. Respiration rate in terms of O_2 consumption

ml/kgh after 18th h under refrigerated condition. The observed reduction in initial higher respiration rate was due to the reduced availability of oxygen inside

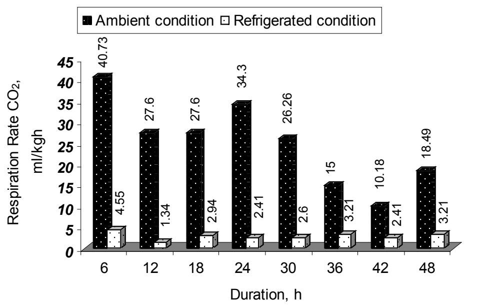


Fig. 6. Respiration rate in terms of CO_2 production

the container under prolonged storage periods found during the study showed that temperature has a significant effect on the respiration rate. The average

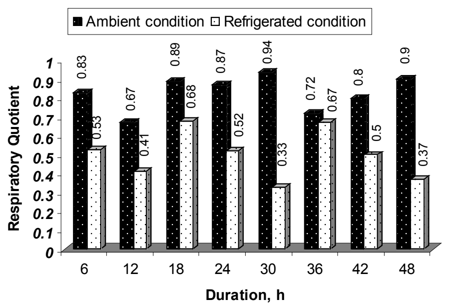


Fig. 7. Effect of storage condition on RQ values

respiration rates in terms of O_2 consumption under ambient and refrigerated conditions were 30.15 and 5.85 ml/kgh, respectively. The maximum respiration rate observed initially was because of aggregate onion suddenly exposed to closed containers then reduced over the period of time. These above results concurred with the findings of Fagoni *et al*. (2001) in tomato having respiration rate of 60 ml/kgh under ambient temperature.

Respiration rate in terms of CO_2 production (ml/kg h)

Respiration rate measured in terms of CO_2 production (Fig. 6) was highest with a peak of 40.73 ml/kgh after 6^{th} h followed by 34.3 ml/kgh after 24^{th} h under ambient condition and 4.55 ml/kgh after 6^{th} h followed by 3.21 ml/kgh after 36^{th} and 48^{th} h under refrigerated condition. The minimum respiration rate in terms of CO_2 production was 10.18 ml/kgh after 42^{nd} h followed by 15 ml/kgh after 36^{th} h under ambient condition and 1.34 ml/kgh after 12^{th} h followed by 2.41 ml/kgh after 24^{th} and 42^{nd} h under refrigerated storage. The reduction in CO_2 evolution was due to the reduced availability of CO_2 inside the container with progress of storage may be due to increased partial pressure of CO_2. The average respiration rates in terms of CO_2 production under ambient and refrigerated conditions were 25.02 and 2.83 ml/kgh respectively indicating the fact that respiration rate decreases with decrease in storage temperature. Increase in CO_2 evaluation leads to anaerobic respiration, so use of lime to absorb CO_2 is important. Decreasing respiration rate during storage is beneficial to maintaining quality and enhances storage life (Bhande *et al*., 2008).

RQ Values

Respiratory quotient values were observed in both ambient condition as well as the refrigerated condition (Fig. 7). The maximum value was observed from the study was 0.94 after 30^{th} h followed by 0.9 after 48^{th} h under ambient condition and 0.68 after 18^{th} h followed by 0.67 after 36^{th} h under ambient condition. The minimum values observed were 0.67 after 12^{th} h followed by 0.72 after 36^{th} h under ambient condition and 0.33 after 30^{th} h followed by 0.37 after 48^{th} h under refrigerated condition indicating the controlling effect of temperature on RQ values. The average RQ values of ambient and refrigerated stored onion was 0.83 and 0.51, respectively. A very high value of the RQ or a sudden shift in RQ value indicates a shift in the respiratory cycle to anaerobic cycle (Saltveit, 2004).

Conclusion

Aggregate onion (*Allium cepa L var aggregatum* Don.) is one of the most important commercial vegetable crops used in our daily life. Storage study revealed that the average respiration rate in terms of O_2 consumption and CO_2 production under ambient conditions were 30.15 and 25.02 ml/kgh and refrigerated conditions were 5.85 and 2.83 ml/kgh, respectively. This shows respiration rate decreased with decrease in storage temperature that helps to enhance the shelf life of the product.

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