ABSTRACT

In controlled atmosphere (CA) storage besides reducing the temperature, the recommended proportion of O_2 and CO_2 concentrations of storage atmosphere are established, monitored and maintained throughout the storage period by employing some external means. But the present equipments used in controlled atmosphere storage are either costly or take long time to establish the desired atmosphere. Liquid nitrogen (LN_2) is an inert gas, which boils at -195.6°C at atmospheric pressure giving latent heat of 199.58 kJ/kg. Both the latent heat and the sensible heat that may be available from vaporized N_2 gas can be used for cooling of fresh produce. Hence, present study was conducted to see the role of LN_2 in CA storage for preservation of apple and litchi fruits.

Literature on CA storage of apple being available, it was selected to evaluate the role of LN_2 in CA storage and to evaluate the control strategy for maintaining the O_2 and CO_2 concentrations of the CA chamber. The operating parameters of the CA chamber thus fixed were used to study the storability of litchi fruit at CA conditions. A model based on the principles of enzyme kinetics was developed to predict the rates of respiration of apple and litchi fruits. A closed system respirometer was used for generating the respiration data at different temperatures viz. 0, 5, 10, 15, 20, 25, 30°C for apple and 2°C for litchi. An airtight CA chamber of about 49.5 cm high, 49.4 cm wide and 29.8 cm long with 10 cm thickness of insulation was developed for LN_2 flushing. A relationship was established for predicting the amount of LN_2 required for reducing O_2 concentration as well as for reducing the temperature of the CA chamber. About 434 g of LN2 was flushed at different flow rates viz. 4.4, 9.33, 20.48, and 35.81 kg/h to get the desired temperature and O_2 concentration of the CA chamber. Study was also conducted to see the effect of cooling rate and O_2 pulldown rate on the quality attributes of apple. An attempt was also made to establish the control strategy for regulating O_2 (1-2%) and CO_2 (1-2%) concentrations by purging the ambient air and LN_2, inside the CA chamber, respectively. At last, the optimum operating parameters of the CA chamber were used to study the effect of rapid

establishment of CA conditions (3-4% O_2, 3-4% CO_2 and 2°C) on quality of litchi fruit.

The respiration rates of apple and litchi fruits predicted through the uncompetitive inhibition enzyme kinetics model were found to be in good agreement with those obtained through experiments within the temperature range of 0 to 30°C. Simultaneous cooling as well as reduction of O_2 concentration using LN_2 had beneficial effects in retaining quality of the fruits compared to those obtained using conventional system. At the lowest flow rate of 4.4 kg/h of LN_2, the chamber temperature dropped to -0.5°C after 355 sec of flushing. During this time O_2 concentration also dropped to the level of 1.83%. Flushing of 3.2 kg of LN2 in the CA chamber containing apples reduced the core temperature of apple to 1°C in 35 minutes. LN_2 purging was also found to be effective for maintaining the CO_2 concentration of the CA chamber. Use of LN_2 could establish rapidly the CA and reduce the quality change of litchi. The storage life of the fruit could be extended more than 7 weeks in comparison to conventional storage.

Keywords:

Apple, Litchi, Postharvest, Respiration rate, Controlled Atmosphere Storage, Modified Atmosphere Packaging, Liquid Nitrogen