GRAPEFRUIT AND MEXICAN FRUIT FLY TOLERANCE TO REFRIGERATED CONTROLLED ATMOSPHERE STORAGE

Krista C. Shellie* and Robert L. Mangan, USDA-ARS, Weslaco, TX

The Mexican fruit fly, *Anastrepha ludens* (Loew), is undesirable in citrus production regions. Citrus fruit harvested from regions infested with fruit fly could contain unhatched eggs or larvae of various ages depending upon the elapsed time between fly ovipositing and fruit harvest. Because infested fruit cannot be easily eliminated by external inspection, regulatory agencies in many countries have established phytosanitary quarantine protocols. Quarantine protocols include preharvest techniques, such as sterile fly release, non-host status, and pestfree growing periods, as well as postharvest commodity treatments. Storage at 0. 6 to 1. 7°C for 18 to 22 d is approved by the Animal and Plant Health Inspection Service of the United States Department of Agriculture as a quarantine treatment against Mexican fruit fly for citrus imported into the United States from Mexico or Central America. However, this treatment is not commercially used because of problems with chilling injury. The objective of this research was to assess whether storage at a nonchilling temperature in an atmosphere with modified levels of oxygen or carbon dioxide could provide quarantine security against Mexican fruit fly without damaging fruit quality.

Tolerance of 'Rio Red' grapefruit, Citrus paradisi Macf., to storage at 10°C in a hypoxic or hypercarbic atmosphere was evaluated in a series of small experiments. Grapefruit quality was evaluated after 14 or 21 days of storage in air, ultra low oxygen (0.05, 0.10, or 0.15 kPa), or high carbon dioxide (20, 40, or 60 kPa). Results from these experiments demonstrated that storage in either 40 or 60 kPa carbon dioxide (balance air) caused a breakdown of flavedo tissue, and that fruit tolerated storage for up to 21 days in ultra low levels of oxygen (0.05, 0.10, or 0.15 kPa) or 20 kPa carbon dioxide (balance air). Grapefruit stored in 0.05 kPa oxygen were rated for flavor as acceptable yet inferior to fruit stored in air or in 0.10 kPa oxygen. Grapefruit stored in ultra low levels of oxygen had a lower incidence of decay, a higher amount of titratable acid, and a lower ratio of soluble solids to titratable acid than grapefruit stored in air.

The mortality of Mexican fruit fly larvae after storage in a refrigerated controlled atmosphere was also evaluated in a series of small experiments. The mortality of third instar larvae that were artificially infested into grapefruit and then stored for 14 or 21 days in air, 0.05 kPa oxygen, 0.10 kPa oxygen or 20 kPa carbon dioxide (balance air) was found to be highest after storage in 0.05 kPa oxygen. Six fife stages of Mexican fruit fly were stored for 21 days on laboratory diet at 10°C in 0.05 kPa oxygen or in air. The number of surviving individuals were counted after removal from cold-storage and holding under optimum rearing conditions. Late third instar larvae and eggs were found to be the life stages most likely to survive cold storage in 0.05 kPa oxygen.

Responses observed in this study for grapefruit were similar to that reported by other researchers. Ke and Kader (1990) found that 'Valencia, orange (c&= *sinensis* (L.) Osbeck) tolerated exposure to 0.02 kPa oxygen at 10°C for up to 20 d without detrimental effects on

external and internal appearance, but developed skin browning and poor external appearance after storage in 60 kPa carbon dioxide. They also found that 'Valencia' oranges developed an acceptable, yet detectable off-flavor during storage in ultra low oxygen and they associated this off-flavor with an increase in tissue concentration of ethanol and acetaldehyde. Davis et al. (1973) suggested that development of off-flavor under anaerobic conditions may also be attributed to a shift in equilibrium toward reduced forms of flavor compounds. Intolerance of grapefruit to storage in elevated levels of carbon dioxide has been reported by Stahl and Cain (1937) and Scholz, et al. (1960). Grapefruit from Florida (Stahl and Cain, 1937; Chace, 1969), and Texas (Scholz et al., 1960) have been shown to tolerate refrigerated storage in a low oxygen atmosphere for up to 4 weeks.

Low oxygen was also found to be more efficacious than elevated carbon dioxide for killing Mexican fruit fly larvae during heating in forced-air (Shellie et al., 1997). Grapefruit heated in I kPa oxygen required 30% less exposure time than grapefruit heated in air to obtain 100% larval mortality. Results from these experiments suggest that storage in ultra low levels of oxygen has potential for disinfesting grapefruit of the Mexican fruit fly.

References Cited

Chace, W.G. 1969. Controlled atmosphere storage of Florida citrus fruits. Proc. 1st Int. Citrus Symp., Univ. Calif Riverside, Calif 3:1365-73.

Davis, P.L., B. Roe, and J.H. Bruemmer. 1973. Biochemical changes in citrus fruits during controlled-atmosphere storage. J. Food Sci. 38:225-229.

Ke, D. and A.A. Kader. 1990. Tolerance of 'Valencia' oranges to controlled atmospheres as determined by physiological responses and quality attributes. J. Amer. Soc. Hort. Sci. 115:779-783.

Scholz, E.W., H.B. Johnson, and W.R. Buford. 1960. Storage of Texas Red grapefruit in modified atmospheres-a progress report. Rep. Agric. Mktg Serv., U.S., No. AMS

Shellie, K.C., R.L. Mangan, and S.J. Ingle. 1997. Tolerance of grapefruit and Mexican fruit fly larvae to heated controlled atmospheres. Postharvest Biol. and Tech. 10: 179-196.

Stahl, A.L. and J.C. Cain. 1937. Cold storage studies of Florida citrus fruits. M. The relation of storage atmosphere to the keeping quality of citrus fruit in cold storage. University of Florida Agricultural Experiment Station, Gainesville, FL. 44p.

[Proc. 1997 Ann. Internat. Res. Conf. On Methyl Bromide Alternatives and Emissions Reduction, San Diego, CA, USA, Nov. 3-5.]