Modified atmosphere packaging (MAP) technology relies upon development of an environment reduced in oxygen (O₂) and/or elevated in carbon dioxide (CO₂) levels inside a hermetically sealed container. There are numerous scientific studies which have documented the effects of reduced O₂ and/or elevated CO₂ atmospheres on reducing respiration, ethylene production, ethylene action, extending shelf-life, and maintaining quality of intact and fresh-cut horticultural commodities (Kader et al., 1989; Zagory and Kader, 1989). However, the use of novel gases, such as argon and helium, instead of nitrogen in gas mixtures has received little attention in the scientific literature. Argon-enriched atmospheres have been observed to reduce C₂H₄ biosynthesis and respiration rates (Lougheed and Lee, 1989). A recent report by Day (1996) as well as a patent by Powrie et al. (1990) have reported on the potential beneficial effects of using argon in gas mixtures. We tested the hypothesis that argon acts as a competitive inhibitor of molecular O₂ possibly by competing for O₂ binding sites and reducing activities of key enzymes involved in C₂H₄ biosynthesis.

Materials and Methods
ACC-oxidase was extracted from near climacteric (166 μl C₂H₄·kg⁻¹·h⁻¹) ‘Bartlett’ pears. Twenty grams of pear tissue were assayed for in vitro ACC-oxidase activity by the method described by Gorny and Kader (1997) with the following modifications. The standard reaction mixtures used in this assay were purged for 10 min with a gas mixture of air, 80% argon + 20% O₂, or 100% argon at a flow rate of 100 mL·min⁻¹; 1.8 mL of the standard reaction mixture was then placed in each test-tube and sealed with a rubber stopper before addition of the enzyme preparation. An exhaust syringe needle was used to pierce the rubber stopper and allow for flushing with the three gas mixtures mentioned above at a flow rate of 100 mL·min⁻¹ for 1 min. Using a syringe the enzyme assay reaction was initiated by adding 0.2 mL of enzyme preparation to each gas-flushed sealed, 15-mL test tube that contained the standard reaction mixture (1.8 mL).

After a 1-h incubation with shaking at 30°C, a 1-mL gas sample was withdrawn with a syringe from headspace for C₂H₄ determination by gas chromatography.

Results and Discussion
In vitro ACC-oxidase activity was similar when the enzyme assay was performed in air or 80% argon + 20% O₂ (Fig. 1). These data indicate that argon does not directly effect ACC-oxidase activity by competing for and displacing molecular O₂ at the attachment site on the protein itself. When O₂ was displaced in the reaction test-tubes with 100% argon, in vitro ACC oxidase activity levels were half of those found in air or 80% argon + 20% O₂. This is likely due to O₂ depletion within the test-tubes, not because of any direct effects of argon gas. Similar results have been reported when in vitro ACC-oxidase activity was measured in reaction tubes that were flushed with 0.25% O₂ + 99.75% N₂ (Gorny and Kader, 1996).

![Fig. 1. The effect of assay atmospheres of air, 80% argon + 20% O₂, or 100% argon on the in vitro ACC-oxidase activity of ‘Bartlett’ pears.](image-url)
Argon-enriched atmospheres, when sufficient O₂ is present, do not directly affect the metabolism of plant tissues by reducing the activity of enzymes (such as ACC oxidase), which require molecular O₂ for activity. Argon may, however, increase the diffusivity of gases such as CO₂ and C₂H₄ from plant tissues because of its higher density than nitrogen. A similar effect has been demonstrated by Burg and Burg (1965) using helium. Argon gas is utilized in the wine industry for sparging the headspace in wine bottles just before the cork is inserted because it displaces O₂ more quickly than N₂. Further research is needed to evaluate the benefit of more effectively displacing oxygen by argon in flexible packages of perishables. But since argon is more expensive than nitrogen, cost/benefit analysis is recommended before commercial application.

Literature Cited


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