

Abstract

Sucrose depletion in harvested asparagus (*Asparagus officinalis* L.) spear tips is rapid and may trigger senescence. This research focuses on investigating how carbohydrate metabolism in asparagus spear tips, stored at 1°C, is regulated. The research was divided in two parts. The first portion was an investigation into the effects of low O₂ and high CO₂ on respiratory and fermentative metabolism, sucrose-metabolizing and glycolytic enzymes, and phosphate and adenylate levels in spear tips. The second portion was an evaluation of the effects of exogenous cytokinin on sucrose metabolism in harvested asparagus spears.

For this portion of the research, spears were stored with a range of O₂ partial pressures combined with CO₂ treatments of 0, 5, 10, and 20 kPa using a system combining modified atmosphere packages in flow-through containers for a period of 6 days. The respiratory quotient increased and ethanol, acetaldehyde, and lactate accumulated below 2 kPa. During 6 days of storage, sucrose declined markedly, relative to harvest. Sucrose content was highest for spears exposed to 5 kPa CO₂. SS activity was higher at harvest; however, bound acid invertase activity was the highest after the storage period, indicating that sucrose may be degraded postharvest mostly in the apoplast. 5 kPa CO₂ reduced sucrose synthase, invertase and hexokinase activities, which may account for the reduction in sucrose utilization. Alcohol dehydrogenase (ADH) and pyruvate decarboxylase activities increased for O₂ levels below 2 kPa. Lactate dehydrogenase activity was lower than ADH activity; however, it also increased below 2 kPa O₂. Visual quality (VQ) was reduced by CO₂, but increased as O₂ increased. VQ was best for spears stored in near-ambient O₂ and 5 kPa CO₂.

Low O₂ enhanced the interconversion of PEP to PYR and F6P to fructose-1,6-bisphosphate (F1,6P₂), indicating a promotion of glycolysis with a resulting loss of carbon in the sugar pool. Low O₂ caused an increase in pyruvate kinase (PK) activity. However, high CO₂ besides having an effect on PK, appeared to affect conversion of F6P to F1,6P₂ at O₂ levels below 2 kPa.

PPi and ATP decreased below 2 kPa O₂, with a concomitant increase in Pi, ADP, and AMP. Low O₂ also reduced adenylate energy charge (AEC) relative to high O₂. Higher CO₂ reduced AEC for O₂ levels greater than 2 kPa. Decreases in PPi, ATP, and AEC, and increases in Pi, ADP, and AMP in response to O₂ deficiency suggest impairment of oxidative phosphorylation and unbalanced cell metabolism, which may limit asparagus spear survival. Below 2 kPa O₂ the cells were under stress leading to fermentation. Below 1 kPa O₂ the spear tip tissues were experiencing severely limiting energy availability.

6-BAP reduced respiration rate of spears with intact tips, slowed changes in fluorescence, and slowed chlorophyll degradation during 31d of storage at 1°C. 6-BAP also slowed the decline in sucrose content in spears with tips. The visual quality was highest for spears with tips that were treated with 6-BAP.