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論文の内容の要約

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学位論文名	Effects of modified atmosphere, controlled atmosphere, and 1-methylcyclopropene on qualities and physiology of ornamental plants

【論文の内容の要約】

In higher plants ethylene is synthesised from methionine via *S*-adenosylmethionine (SAM) and 1-aminocyclopropane-1-carboxylic acid (ACC). The conversion of SAM to ACC is catalysed by ACC synthase (ACS), and ethylene is produced from ACC by ACC oxidase (ACO). In carnation, an increase in ethylene production is associated with the increment of the gene expressions of ACS and ACO.

The negative effects of ethylene can be significantly reduced by treatments with inhibitors of ethylene perception such as 1-methylcyclopropene (1-MCP) gas. 1-MCP has been reported to extend the postharvest life of a wide range of plant species, including roses (*Rosa hybrida* L.) and cut phlox flowers (*Phlox paniculata*). In cut carnation ‘White Sim’, the vase life can be doubled after treatment with 20 nL · L⁻¹ 1-MCP at 20 °C for 6 h.

Modified atmospheres (MA) refer to a system in which air is replaced either totally or in part by other gases. Usually this involves elevation of CO₂ and/or reduction of O₂ concentrations.

Over the course of storage, the passive MA will be modified as a result of metabolic activity of commodities and permeability of the packaging films. With active MA, initial gas flushing or the introduction of a gas scavenging system within the package is used to accelerate gas composition modification to avoid product exposure to high concentrations of unsuitable gases. MA benefits include reduced respiration, ethylene production, and sensitivity to ethylene; retarded softening and compositional changes; alleviation of certain physiological disorders; and reduced decay. Controlled atmosphere (CA) as well as MAP is a technique used commercially for apples, but recently this technique has been applied gradually to other horticultural products. Studies on CA responses have included commodities such as fruits, vegetables and fresh-cut products. At present little information is available about ethylene production rates together with respiration rates and vase life of cut flowers under CA or high CO₂ treatments.

Exposure to ethylene and increased ethylene production often shorten the vase life of cut flowers and display life of potted plants such as carnation, *Impatiens*, *Eustoma* and *Cattleya*. Inhibitors of ethylene perception such as 1-methylcyclopropene (1-MCP) has been reported to extend the postharvest life of a wide range of ethylene-sensitive flowers, while physiological effects of 1-MCP on ornamental plants have not been well examined and its practical application has not been established. Exposure to low O₂ and/or elevated CO₂ is an additional strategy to maintain the postharvest longevity of ornamental plants. Controlled atmosphere (CA) and modified atmosphere (MA) are effective means for extending the postharvest longevity of

various fruits and vegetables, while effects of CA and MA packaging (MAP) on ornamental plants have been less extensively and intensively studied. Therefore, the influence of 1-MCP, CA and MAP on maintenance of quality of ornamental plants was investigated in this study.

The effects of MAP and 1-MCP on the qualities and longevity of florets were investigated in potted carnation 'Scarlet'. MAP with and without $1 \mu\text{L}\cdot\text{L}^{-1}$ 1-MCP (2 day-exposure) for whole plant at $22/17^{\circ}\text{C}$ (day/night) significantly reduced ethylene production and delayed wilting of florets by 2 days, and prolonged the display life from 7.0 to 9.4 days after harvest (DAH).

To fully understand the benefits of MA and 1-MCP for carnations, further analyses were conducted using cut florets of potted carnations under active MA conditions. In the experiment for cut florets, active MA (a-MA; initial gas, 2.75% for CO_2 and 11.5% for O_2) for 2 days prolonged the longevity by 2 days, whereas a-MA in combination with the 1-MCP (a-MA/MCP) treatments prolonged longevity by 7 days. Maximum ethylene production was significantly decreased by a-MA, while an only trace amount was detected in a-MA/MCP. The expression of *DcACS2* and *DcACO1* in the florets were repressed by a-MA/MCP treatment associated with lower ethylene production than in the control. Moreover, the higher levels of carbohydrates were found in the treated florets.

In potted *Impatiens*, the combination of MAP with 0.1 and $1 \mu\text{L}\cdot\text{L}^{-1}$ 1-MCP at 23°C (2 day-exposure) maintained the qualities by increased floret longevity, number of opened flower as well as plant longevity. Effect of treatments varied with cultivars; there were effective in 'Peach'

and 'Rouge' but not in 'Purple tripe'.

In addition, potential effects of short-term CA (10%, 15%, 20%, or 50% CO₂ at 5°C and 23°C for 2 h) and 1-MCP on vase life of cut carnation, *Eustoma* and chrysanthemum flowers were investigated. Treatment with short-term CA and 1-MCP reduced the ethylene production rate in cut florets of carnation. Short-term CA with 10, 15 or 20% CO₂ and 1-MCP treatments delayed senescence and prolonged the vase life of cut carnations (from 10.2 to 13.3 days) and *Eustoma* (from 8.3 to 11.2 days, but they were not effective in chrysanthemum).

Our results indicate that high CO₂ in MAP, active MA and short-term CA with or without 1-MCP improve the qualities of potted ornamental plants and cut flowers, by reducing ethylene production and respiration as a result to reduce metabolism of plants. The treatments delayed the ethylene-induced senescence such as petal wilting in cut flowers, which is consistent extending the florets longevity. Moreover, ethylene biosynthesis genes in the gynoecium of carnation florets were repressed, in agreement with low ethylene production in the treatments.

MAP and CA storage for ornamental plants are not widely practiced. However MAP, CA and combination with 1-MCP treatments have been demonstrated to extend the postharvest life of certain potted ornamental plants (e.g., carnation, and *Impatiens*) and cut flowers (e.g., carnation and *Eustoma*). Although the MAP and CA research and development to date shows promise for selected ornamental plants, these technologies have not yet been proven effective across the broad range of diverse species that characterize the ornamental plants industry.

Accordingly, commercial interest in MAP and CA treatments for ornamental plants is likely to remain low until the benefits and proper cost issue can be demonstrated. Our result, these technologies imply some additional reasonable costs and main advantage is that ensures the maintaining qualities of products. Thus, these techniques are feasible tool to prolong longevity of cut flowers and maintain the visual value of potted ornamental plants.

In conclusion, MA, CA, 1-MCP and their combinations can result in reduction of senescence, along with associated biochemical and physiological changes, i.e., reduced respiration and ethylene production rates, slowed decreasing of carbohydrates content, wilting, and repressed expression of ethylene biosynthesis gene especially in ethylene-sensitive ornamental plants.