University, Cheongju 361-763, Korea, 2Brain Korea Center for Bio-Resource Development, Chungbuk National University, Cheongju 361-763, Korea

Various environmental stressors can be used to induce the accumulation of health-promoting phytochemicals in plant-based foods. The objective of this study was to determine the effect of temporary low temperature on the concentration of phenolic antioxidant compounds in kale (*Brassica oleracea* var. *acephara*). For the low-temperature treatment, two kale cultivars ('Manchoo Collard' and 'TBC') grown for 3 weeks in a growth chamber were subjected to 4°C for 3 days, and subsequently allowed to recover for 2 days under normal growth conditions. Fresh and dry shoot and root weights, chlorophyll fluorescence ratio (Fv/Fm), reactive oxygen species (O_2^- and H_2O_2), total phenolic content, antioxidant capacity, individual phenolics, and phenylalanine ammonia lyase (PAL) activity were measured before and after treatment. No significant difference was observed between the control and low-temperature treatments in the fresh or dry shoot or root weights of either cultivar. The Fv/Fm ratio decreased during the low-temperature treatment in both cultivars, and O_2^- and H_2O_2 were generated in 'Manchoo Collard' leaves at low temperature but not in 'TBC' leaves. 'Manchoo Collard' had a 15% higher total phenolic content than the control after 2 days of recovery, whereas that of 'TBC' was 16% lower than that of the control. Individual phenolic compounds, such as caffeic acid, ferulic acid, and kaempferol, exhibited a similar trend to the total phenolic content and antioxidant capacity. The increased PAL activity in 'Manchoo Collard' at low temperature was in accord with the total and individual phenolic content results. These results suggest that a temporary period of cultivating kale at low temperature in a controlled environment is a potential strategy to increase the plant's phenolic antioxidant compound content.

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T. 043-532-0018, jhjh@cbnu.ac.kr

7 O-1-①

Morphological Characteristics of Flower Organs at Different Flower Developmental Stages in Various Strawberry Cultivars

Meiyan Cui[1], Yurina Kwack[2], Hyunseung Hwang[1], and Changhoo Chun[1,2]*
[1]Department of Plant Science, Seoul National University, Seoul 151-921, Korea, [2]Research Institute of Agriculture and Life Science, Seoul National University, Seoul 151-921, Korea

To clarify the differences of flower morphology among major cultivars of strawberry, we observed the flower organs of 'Akihime', 'Keumhyang', 'Meahyang', and 'Seolhyang' in different flower developmental stages using scanning electron microscopy (SEM). Flowers were classified into three developmental stages: the stamen formation period (stage I), pistil formation period (stage II), and receptacle enlargement period (stage III). At stage I, we could not observe a significant difference in flower morphology among four strawberry cultivars. At stage II, the length of pistil in 'Akihime' was longer compared with the other cultivars. The shortest pistil and the stigma with a strongly wrinkled surface were observed in 'Maehyang'. At stage III, the length to width ratio of anthers was significantly greater in 'Maehyang' and 'Seolhyang' comparing with those in 'Akihime' and 'Keumhyang'. After dehiscence of anthers, we measured the number of pollen grains and found that 'Keumhyang' had the greatest number of pollen grains, while that in 'Maehyang' was the smallest. Results would provide fundamental information to investigate causes of morphological changes in flower organs and fruit malformation in strawberry.

T. 02-880-4567, F. 02-873-2056, changhoo@snu.ac.kr

8 O-1-②

Theoretical and Experimental Analyses of Ion Balance in Completely-and Semi-closed Soilless Cultures of Paprika

Tae In Ahn, Jong Hwa Shin, and Jung Eek Son*
Department of Plant Science, Seoul National University, Seoul 151-921, Korea

Ion balance in soilless culture could be controlled by leaching drainage or adjusting ion ratios in stock solutions. In closed soilless culture system, the analysis technique of ion concentrations is important for the control of ion balance because the amount of leachate from the system is completely or partially limited. However an electrical conductivity-based system, which is commercially used, has uncertainties in sensing and control of the ion balance and has no reliable technical platform. The objective of this study was to minimize the instability of the techniques through the theoretical and experimental analyses of ion balance changes. For theoretical analysis of ion balance, models to simulate the transport of nutrient solutions, nutrient uptake by plants, and mixing processes in the open, semi-closed, and completely-closed soilless culture systems were constructed. Transpiration rate was integrated into the ion uptake model as plant growth parameter. An empirical model was used to minimize errors in estimation of total ion amount in the substrate. The ion uptake model was calibrated with measured data. The change of ion balance with injection amounts of nutrient solution was measured. The performance of each soilless culture system with respect to ion balance was analyzed by changing system variables such as irrigation rate, plant growth parameters, and drainage mixing ratio. Simulated values of ion injection amount and ion balance changes were well matched with the experimental ones. Deviations between current and initial ion ratios at the end of the experiment showed an exponential decrease with decrease of drainage mixing ratio. The periods required for changes in ion balance became longer with decrease of the plant growth parameter. Through this study, a theoretical platform for quantitative analysis of ion balance and ion injection amount in soilless culture was developed and proved to be functionally effective for reducing the uncertainties in closed soilless cultures.

T. 02-880-4564, sjeenv@snu.ac.kr