Effects of Water Deficit on Regulation of Phenolic Antioxidants and Betalain Pigments in Portulaca oleracea (Portulaceae)

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Introduction
As a result of global climate change, water availability may change dramatically, a shift that would undoubtedly impact plant life. The aim of this study was to investigate the response of two varieties of Portulaca oleracea to water deficit. Morphological data were collected as measures of fitness. Chemical analyses were conducted on phenolic antioxidants and betalain pigments.

Design
Seeds were germinated and established during a 2 week period with ample water. They were then assigned to one of three treatments (300 mL/week, 150 mL/week, and 0 mL/week) which lasted 3 weeks.

Data Collected
Infrared spectroscopy (FTIR) was used to determine a chemical fingerprint for the plant. The betalain pigments found in the stems were extracted and filtered using a visible spectrometer to collect their absorbance values at 477 nm and 546 nm.

Results
Does water deficit result in morphological responses? YES
The treatments had a significant impact on the morphology of the plants in both cultivars. Plants in the low water treatment were smaller, produced fewer flowers and nodes, and they lost more leaves than the plants in the high and medium water treatments.

Does water deficit cause increased antioxidant production? YES
Does water deficit cause increased production of betalain pigments? YES
Does water deficit cause a chemical change in a leaf's cuticle? NO

Questions
1. What is the effect of water deficit on morphological responses?
2. What is the effect of water deficit on antioxidant production?
3. What is the effect of water deficit on betalain production?
4. What is the effect of water deficit on the plants' cuticle?
5. How will the two genotypes differ in their responses to water deficit?

Discussion
Portulaca oleracea is a very drought resistant plant. Withholding water for 3 weeks did not cause the plants to die; however, they were obviously stressed by the end of the trial. An extreme water deficit was required to cause a response in the plants. The medium water treatment received half as much water as the high water treatment, but there was little difference between plants in these two treatments.

Inducing a water deficit in Portulaca oleracea caused a predictable but dramatic response in the plants' morphology. A variety of chemical responses were observed including: increased production of phenolic antioxidants and betalain pigments in the low water treatment. The plants from the low water treatment were smaller than their counterparts in the other two treatments. Significant changes in the plants' cuticles were not observed.

Plants experiencing drought usually close their stomata to reduce water loss, resulting in reduced photosynthesis. Because these plants continue to intercept a high volume of photons that aren’t used in the photosynthetic process, leaves and photosynthetic stems of water-stressed plants may generate reactive oxygen species that can lead to photosynthetic stress. Uprolution of phenolic antioxidants, including betalains, may mediate the effects of these damaging ROS, and allow plants such as purslane to withstand periods of water deficit.

Is there a correlation between the phenolic antioxidants in the leaves and the betalain pigments in the stems? POSSIBLY

Future Directions
1. Is there increased antioxidant activity in the low water plants?
2. Detailed investigation of antioxidants using other antioxidant assays.
3. What is the benefit of producing more antioxidants during a drought?
4. What is the functional purpose of betalains?
5. Further investigate the trends observed in this study using NMR & mass spectroscopy.
6. Investigate the impact of water deficit on lipid composition.
7. Investigate correlations between betalain and antioxidant production.

Acknowledgments
I would like to thank Christy Miller and Betsy Brown for their expertise and assistance in chemical spectroscopy and data entry. I would also like to thank DePauw University's Biology, Chemistry, and Biochemistry students and faculty for their support and advice. And thank you to the Johnson Research Library, DePauw University Library, for providing the necessary equipment and resources for this project.