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# Mechanical Strength Comparison of Hydrated and Dehydrated Pteridium Stems

Michelle I. Kang
*Pepperdine University*

Kevin M. Ko
*Pepperdine University*

John H. Noh
*Pepperdine University*

Veronica R. Vega
*Pepperdine University*

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**Michelle I. Kang, Kevin M. Ko, John H. Noh, Veronica R. Vega**

***Division of Natural Science, Pepperdine University, Malibu, 90263***

## Abstract

In this experiment, the mechanical strength of *Pteridium* stems was tested in two differing conditions: hydrated and dehydrated. It was hypothesized that there would be an increased performance of hydrated stems in the presence of mechanical stress. In order to test this hypothesis, twelve 20 cm pieces of stems were cut in alternation, separating those that would be dehydrated (6) with those that were hydrated (6). The dehydrated specimens were left to dry over a period of 24 hours. The diameters of each individual stem were measured to account for variation in size and remove excess variables. All twelve stems were placed into the Instron individually and their MOE and MOR were measured. Based on the raw data that was obtained from these tests and analysis of the data performed in the form of a paired t-test, it was concluded that there is not a significant difference between the two. Both the MOE's and MOR's of the hydrated and dehydrated stems resulted in p values that were more than the significant 0.05 level. Although the data was found not significantly different, it is an important discovery in the scientific community.

## Introduction

The succession of plants transitioning from the ocean onto land was largely due to the development of tracheary cells to keep the plants from desiccating and to provide them the means of mechanical strength through rigidity (Bailey 1953). Plants most popularly known for their vascular traits are gymnosperms with their tracheids and angiosperms with their vessels. Both vascular transport systems have their own advantages and disadvantages when addressing stimuli that put the plant in severe conditions such as cavitation due to mechanical stress or the need to be bigger for better conducting efficiency (Sperry, Hack, and Pittermann 2006).

Curiously enough, ferns have been a topic of discussion and research when observing their vascular transport. As a primitive plant, different from both gymnosperms and angiosperms because it lacks seeds or flowers, its type of vascular transport has been debated for decades. Contrary to preconceived thought, studies made in the twenty-first century suggest that ferns display vascular transport with an overlap of both vessel elements and tracheids, giving them both mechanical strength and a means of better water conduction (Carlquist and Schneider 2001). Before such conclusions, the only ferns known to have distinct vessel elements were of the *Pteridium* genus. This correlates to the dry environments that require ferns to take up as much water as possible before conditions become harsher (Carlquist 1975). The fibers of its vascular transport are tightly supported by groupings of schlereid cells offering the plant mechanical support adequate enough for the fern to grow large even without secondary, woody growth.

With this information in mind, we are interested in testing the mechanical strength associated with ferns and how they would fare in varying conditions. We decided to test the differences in mechanical strength between dehydrated and hydrated ferns, hypothesizing that the hydrated fern stems would do better under mechanical stress.

## Data/Results

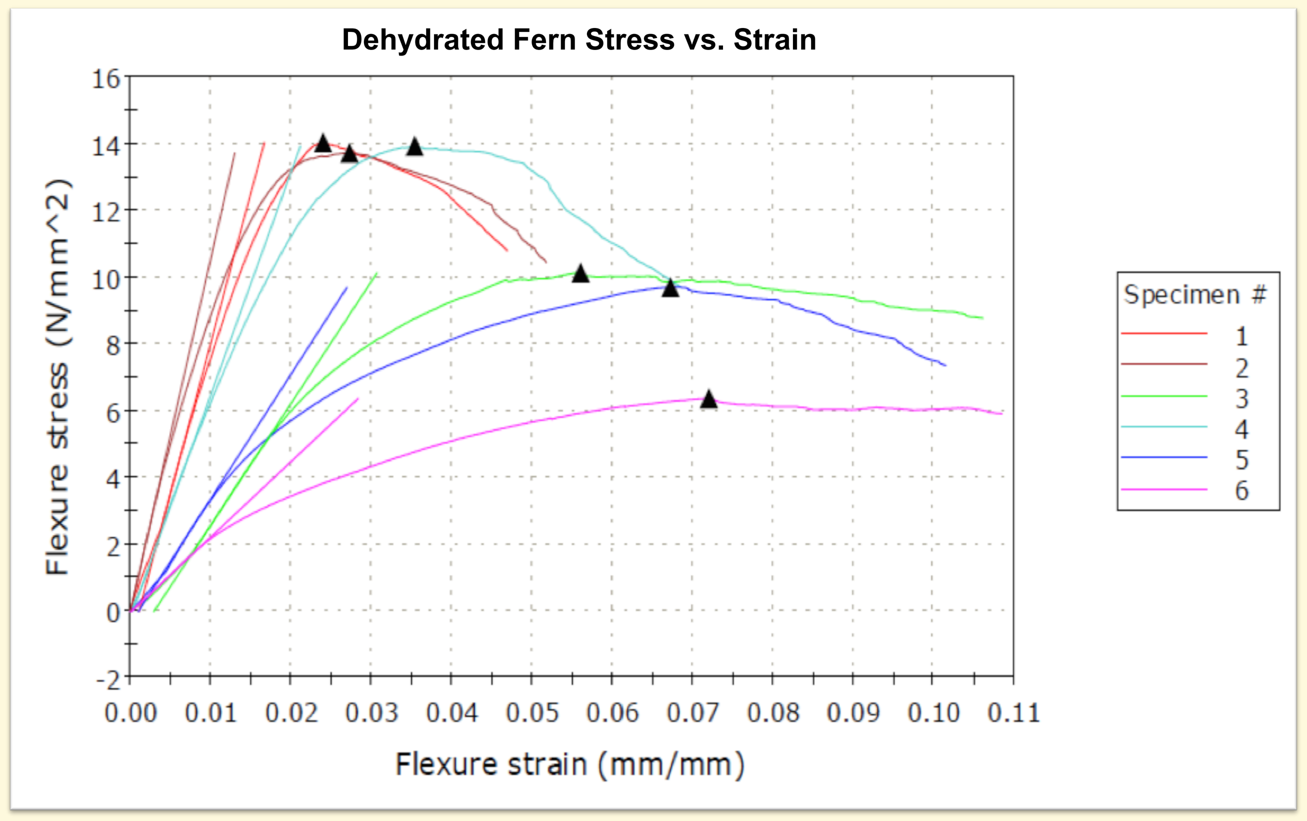


**Figure 5:** The six specimens of dehydrated fern stems were tested with increasing amounts of stress (y-axis) with the Instron. How far the stems were able to flex (flexure strain) before their point of rupture is on the x-axis. The black triangles represent the point of rupture of each stem.

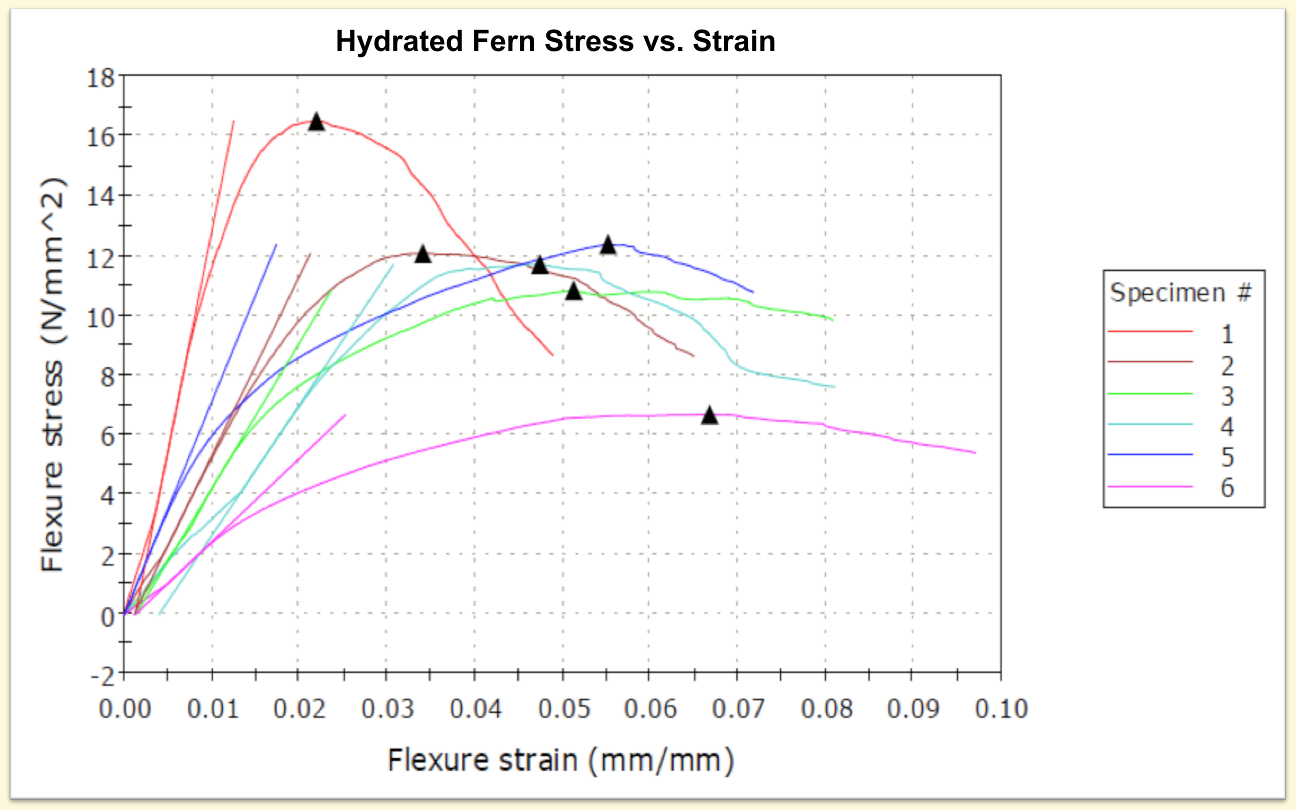


**Figure 6:** The six specimens of hydrated fern stems were tested with increasing amounts of stress (y-axis) with the Instron. How far the stems were able to flex (flexure strain) before their point of rupture is on the x-axis. The black triangles represent the point of rupture of each stem.

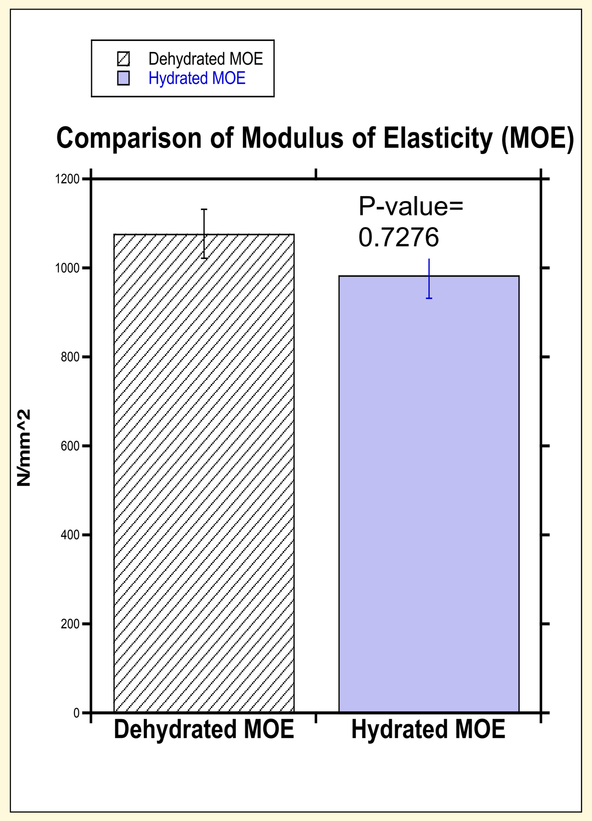


**Figure 7:** Paired Student t-test comparing mean dehydrated and mean hydrated stem MOE. The p-value was found to be 0.7276 at a significance level of 0.05. They are not significantly different because p>0.05.The standard error of the mean dehydrated MOE was found to be 226.896 and that of the mean hydrated MOE was found to be 222.063.

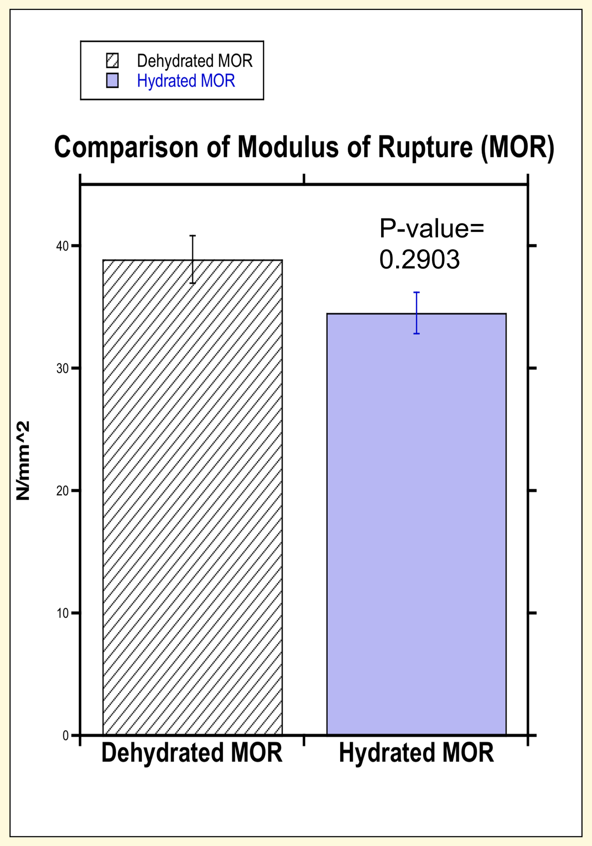


**Figure 8:** Paired Student t-test comparing mean dehydrated MOR and mean hydrated stem MOR. The p-value was found to be 0.2903 at a significance level of 0.05. They are not significant different because p>0.05. The standard error of the mean dehydrated MOR was found to be 3.7846 and that of the mean hydrated MOR was found to be 3.78696.

## Methods

**Figure 1:** Samples of *Pteridium* were collected outside of Pepperdine OneStop.

**Figure 2:** A total of six samples were taken and cut into two 20 cm sections. One section of each sample was experimented on right away as "hydrated" and the other section was set aside to dehydrate for 24 hrs. Sections were alternated between hydrated and dehydrated to reduce variables

**Figure 3:** Careful measurements of the characteristics of each sample were taken with a vernier caliper and recorded into the Instron computer program.

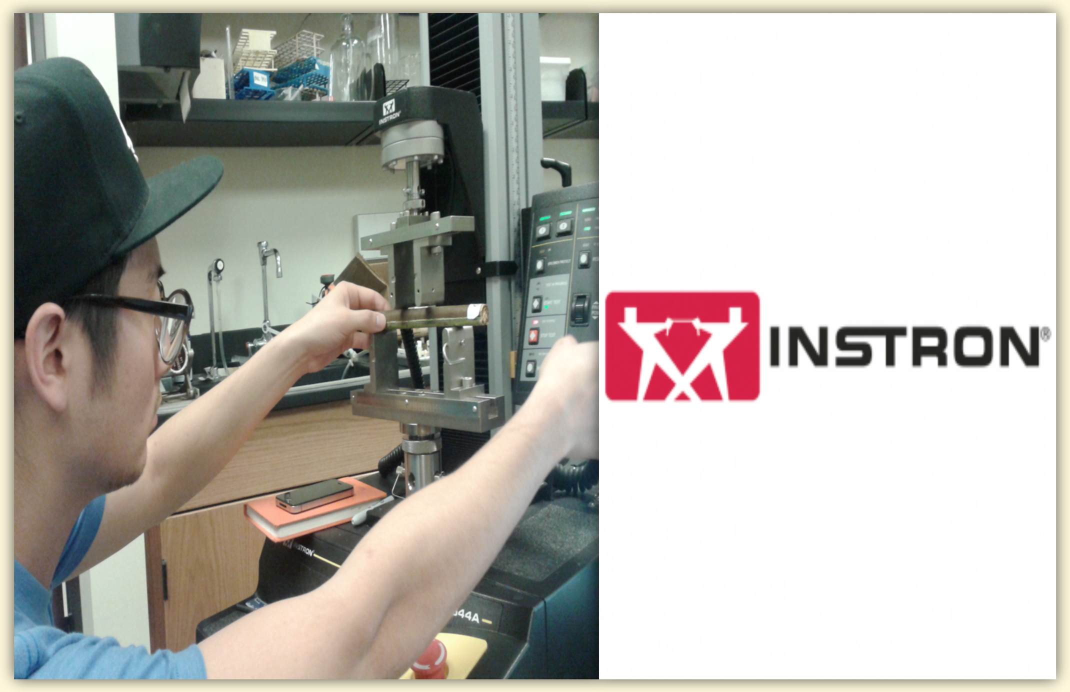


**Figure 4:** Each section was placed into the Instron and appropriate adjustments were made to the instrument to fit the specific sample. Afterward, the machine was run until a breaking point was seen through the program.

## Discussion

As the data shows, the presence of water in *Pteridium* ferns has no significant difference in the mechanical strength of their stems. With a p-value of 0.7276 in the comparison of the MOE and a p-value of 0.2903 in the comparison of the MOR, it can be seen that they are not about or below the 0.05 threshold. It was originally hypothesized that the hydrated stems would perform better under mechanical strength thus having a significantly lower MOE and MOR. However, the data has shown otherwise.

These findings may be more understandable when viewed in correspondence with previous studies and findings. As stated in the introduction, *Pteridium* have been found to have distinct vessel elements which are used for the transportation. The fibers of the transportation vessels are surrounded schlereid cell groups which provide structural support for the plant. With this information it can be hypothesized that even in the absence of hydration, these schlereid cell groups provide the stems with enough support to result in no significant differences between hydrated and dehydrated stems.

However, with the data that has been obtained, such a hypothesis is merely speculation. More experimentation must be performed, including larger sample sizes, more variation, and different species of primitive ferns. For the sake of this experiment, only one type of fern was used, with a sample size of 6 and dehydration time of 24 hours. With further research on this topic, there can be a increased understanding of how water transportation occurs in more primitive plants and how it affects their overall performance and structure.

Overall, with a greater understanding of primitive plants, it will ultimately help to shed light onto the greater purpose, which is the of evolution of plants species, which gives rise to the more advanced gymnosperms and angiosperms we know today. The more we learn about these primitive plants, the more we can learn about plants as a whole.

## Conclusion

- The raw data from the Instron graphs reveal an apparent difference between stress response of hydrated and dehydrated *Pteridium* stems.
- The Student paired t-test shows that there is no significant difference between the mechanical properties of the hydrated and dehydrated fern stems.

## Literature Cited

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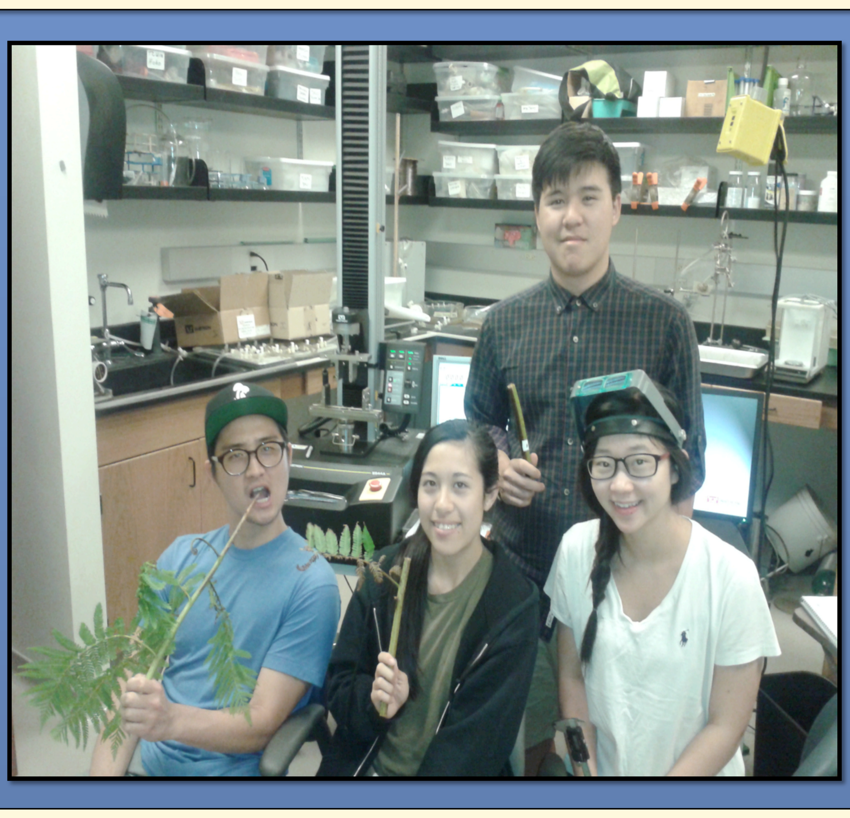

## Acknowledgements

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