The potential role of saponins in host use by the inflorescence stalk-feeding moths *Prodoxus*: a comparison among *Yucca* species

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Introduction

Yucca plants host a community of specialist moths that are solely dependent on the plants as a source of food for their developing larvae. In many cases, each moth species uses just a single plant species[1,2]. One genus of yucca moths, *Prodoxus*, parasitize the plant and lay their eggs in either the inflorescence stalk or developing fruit. Previous research using the generalist species *P. decipiens*, which uses six *Yucca* species, has shown that local populations are able to parasitize native *Y. filamentosa* but are unable to survive on the stalks of non-natal yucca species that are otherwise found within the moth's natural range (Figure 1). This result suggests that plant defenses may contribute to local adaptation and specialization[3].

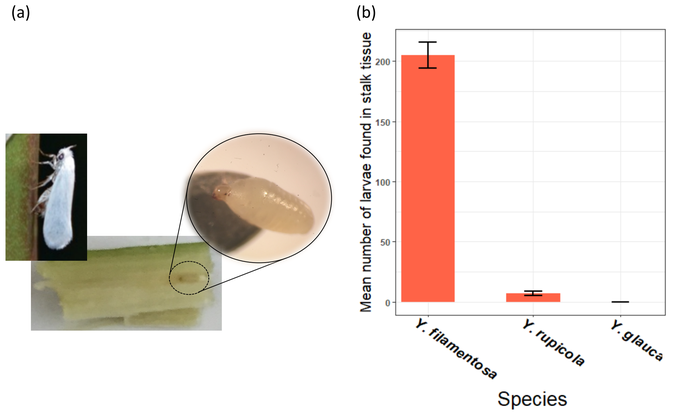
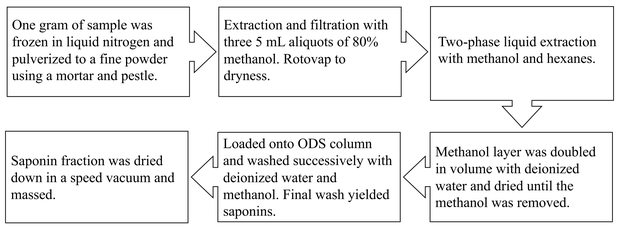


Figure 1: *(a)* Cross-section of a 1 cm piece of yucca stalk with a *P. decipiens* larva feeding inside. *(b)* Larval survival in inflorescence stalks from *Yucca* species. Survival on the native host, *Y. filamentosa*, is significantly higher than on non-native hosts.

Saponins are a major plant defensive chemical that have anti-microbial, anti-fungal, and insecticidal properties[4,5]. *Yucca* is known to have high steroidal saponin content and is used as a commercial source of saponins for food additives and cosmetic products[5,6,7]. The goal of this study was to compare the absolute and relative saponin concentrations found within the inflorescence stalk of several *Yucca* species used by *Prodoxus* to determine if saponin content may correlate with the ability to feed within a *Yucca* species.

Methods

Stalks were collected from an experimental garden in Syracuse, New York or from field sites in North Carolina. The method of extracting saponins pictured below was adapted from Kursar et al.[8]. All data analyses were conducted using the statistical software R.



Results

Do *Yucca* species differ in saponin content of the inflorescence stalk?

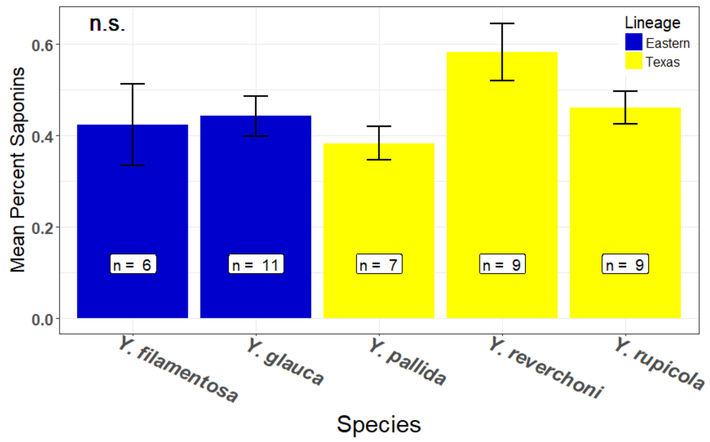
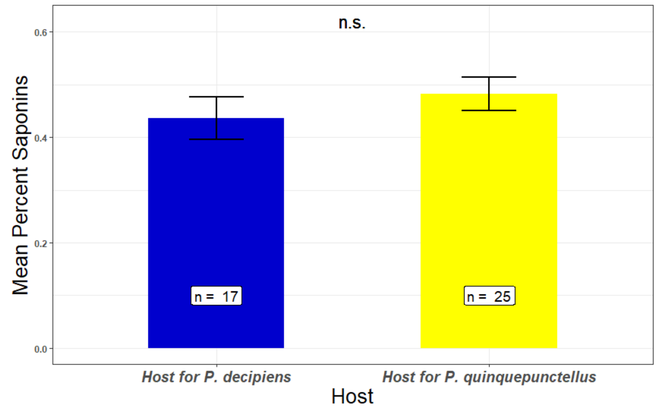


Figure 2: The mean percentage of saponins found in stalks across five yucca species. There was no statistical difference among species.

Are there differences in saponin content of the *Yucca* hosts used by sister species of *Prodoxus*?

Figure 3: The percentage of saponins found in yucca stalks according to the species that parasitizes them. *Y. glauca* and *Y. filamentosa* serve as hosts for *P. decipiens* while *Y. rupicola*, *Y. pallida*, and *Y. reverchoni* serve as hosts for *P. quinquepunctellus*. There was no statistical significance between these two groups.



What effect does hybridization between *Yucca* species have on saponin concentrations?

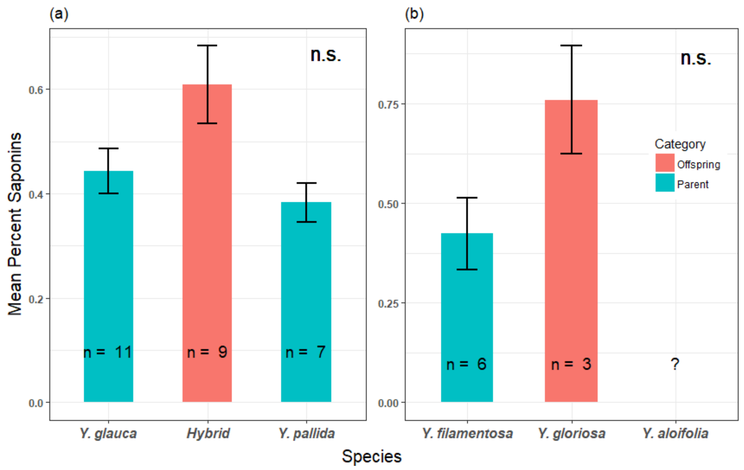


Figure 4: *(a)* Comparison of an as yet unnamed hybrid between its parents *Y. glauca* and *Y. pallida*. *(b)* Comparison of the hybrid *Y. gloriosa* to its parent *Y. filamentosa*; *Y. aloifolia*, the other parent, was not examined in this study. Although the hybrids appear to have slightly elevated saponin concentrations, there was no statistical difference with their parents.

Conclusions

The inflorescence stalks of yucca plants contained only minimal amounts of saponins, accounting for less than 1% of the stalk tissue, and there was no statistically significant variation in saponin content among *Yucca* species or groups (based on primary insect herbivore). Hybridization appeared to increase saponin content, but this variation also was not significant.

Since a yucca plant no longer has any need for the inflorescence stalk once it is done fruiting, manufacturing saponins to ward off insect herbivores would be a costly investment. Herbivory by *Prodoxus* would thus be benign for the plant and better classified as commensalism than parasitism. Specialization of *Prodoxus* species on different populations or species of yucca may therefore depend upon some other trait of the stalk that is not intended for plant defense.

The possibility exists that *Yucca* species vary in terms of saponin composition and that this could be a determinant of host use by *Prodoxus*. The next steps are to examine variation in the saponin composition across *Yucca* species and directly feeding saponins extracted from yucca stalks to *Prodoxus* larvae to determine whether or not they are susceptible to the insecticidal properties of saponins.

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