Is *Hedysarum mackenziei* (Wild Sweet Pea) Actually Toxic?

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Research

Abstract

Hedysarum mackenziei Richardson (wild sweet pea, bear root) is widely regarded as toxic and warnings about confusing it with its edible cousin *Hedysarum alpinum* Richardson (Eskimo potato) abound. To find the chemical basis for this claim, we performed an exhaustive comparison of the secondary chemistry between the two plants as well as a search for nitrogen containing metabolites (alkaloids) in both species. No chemical basis for toxicity could be found. These results were consistent with a subsequent cytotoxic assay performed on an extract of *H. mackenziei*. Finally, a critical examination of the literature could find no credible evidence that *H. mackenziei* is toxic in spite of these widespread rumors.

Introduction

Hedysarum is a loosely defined genus of over 80 species of the Fabaceae family, and in Alaska three species can be found - *Hedysarum mackenzii* Richardson, *Hedysarum alpinum* Richardson, and *Hedysarum hedysaroides* (L.) Schinz & Thell. Common names for *H. mackenziei* include bear root and wild sweet pea, while *H. alpinum* is often referred to as Eskimo potato or licorice root. The roots of *H. mackenziei* have historically been regarded as being mildly poisonous (Heller 1993, Hulten 1990, Kari 1991, Pojar & MacKinnon 1994, Pratt 1996, Schofield 1989) while *H. alpinum* is generally agreed upon to be edible (Holloway & Alexander 1990, Moerman 1998). A more recent view by Jon Krakauer, in his book / movie "Into the Wild," (Krakauer 1997, Penn 2007) suggests that *H. mackenziei* and the seeds (only) of *H. alpinum* are both toxic. Our goal in this work was to find the chemical basis for *H. mackenziei*'s toxicity.

Materials and Methods

Plant material was collected between July and September 1995, mainly off of Groin road in the Chena Flood Plain located near North Pole, Alaska. Additional samples were collected along the Parks, Nenana, Richardson, and Steese Highways of interior Alaska. Voucher specimens (ALA ext #V119746, V119747) were deposited at the University of Alaska Museum. The samples were separated into root, seed, leaf, flower, and stem parts and immediately stored at -20°C except for the flowers which were first freeze-dried.

An exhaustive extraction of each *Hedysarum* sample was performed by three successive two-day extractions in acetone (10mL/g plant material). For the total extract, the combined extracts were concentrated and lyophilized. For the "alkaloid" samples, the combined extracts were concentrated and then partitioned between $CHCl_3$ and 1M HCl, and the organic layer extracted twice more with HCl. The aqueous layer was rendered basic with saturated $NaHCO_3$ and extracted with $CHCl_3$.

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TLC analyses of extracts from each collection were performed using Merck silica gel 60 F-254, and eluted with $CHCl_3$ or MeOH in $CHCl_3$ (5:95). Plates were developed by charring (6% $H2SO_4$ in EtOH followed by mild heating), or using one of the following alkaloid spray reagents (Baerheim-Svendsen & Verpoorte, 1983): Dragendorff, iodoplatinate, $Ce(NH_4)_4(SO_4)_4$, and Marquis. For plates developed with an alkaloid reagent, positive controls of tobacco extract, coffee ground extract and black pepper extract and negative controls of camphor, terpineol, salicin, menthol, or ascorbic acid were also applied to the plates.

A biological assay was conducted using the filter paper inhibition zone assay as described by Lokvam and Braddock (1999) on Bacillus megaterium plates, incubated at 27°C for 24 hours.

14N NMR spectra of the total extracts were acquired on a 90 MHz (1H) JOEL FX-90Q FT-NMR, using $CDCl_3$ as the solvent and pyridine, dimethylformamide, and acetonitrile used as positive controls.

Results

Alkaloid extract composition

Comparison TLCs of the "alkaloid"-extract versus the total extract showed no difference in composition, and in fact the same components could be isolated regardless of whether the original extract was partitioned between $CHCl_3$ and water, $CHCl_3$ and acid, or $CHCl_3$ and base. This result suggested that the partitioning between layers was based on lipophilicity, rather than acid-base properties of alkaloids. Alkaloid spotting reagents yielded negative results with the single exception in a preliminary experiment using Dragendorff reagent that could not be reproduced. No signal could be observed in the 14N NMR spectra of either species.

Comparative TLC results

Extensive TLC comparisons of root, seed, leaf, flower, and stem extracts of the two *H.* species showed a very high degree of commonality between both plant parts and plant species. The root extracts were indistinguishable by TLC, save two additional spots in the edible *H. alpinum* root extract. Likewise the seed extracts were identical, save one additional spot in the *H. alpinum* seed extract. In particular, the spot that gave a nonreproducible Dragendorff positive was present in both species based on TLC comparisons.

Preliminary cytotoxicity assay

Crude extracts from *H. mackenziei* root, *H. alpinum* root, and *H. alpinum* seed were tested for cytotoxicity in a filter paper zone inhibition assay, and in all cases the bacterium completely overgrew the filter paper disks.

Discussion

Results from laboratory work

The lack of inhibition in the cytotoxicity test and the lack of components unique to the *H. mackenziei* species compared to the edible *H. alpinum* species strongly suggest *H. mackenziei* is not toxic. In addition, our inability to detect nitrogen containing compounds in *H. mackenziei* using specialized spray reagents, nitrogen NMR and selective extraction methods demonstrates that alkaloids, the most likely class of toxic compounds, are absent in detectable levels.

Anecdotal evidence

Statements of *H. mackenziei*'s toxicity can be traced back to a journal entry by Sir John Richardson of his exploration of the Alaskan interior in the early 1800's. According to Richardson, *H. mackenziei* tubers were included in a stew for dinner one night, and the next morning the expedition was so ill that no progress could be made. A published version of this journal is available in University of Alaska's Rasmunsen library (Houston 1984), and in it the incident is reported, as well as other episodes where the Richardson party included **ledum** and cranberries in their meals (both of which are known to cause sickness if consumed in large quantities). Even more disturbing, there are descriptions of the party feeding on lichens, leather, rotten meat, warble-fly dung, and fish entails dug up days after the original meal of fish. The party was not well-prepared for boreal exploration, and were often at the point of starvation, and thus any claim of "poisoning" by Richardson is circumspect, to say the least.

Additionally, it can be difficult for novices to distinguish the two *Hedysarum* species, and they often grow side-by-side in the same habitat (Holloway & Alexander 1990). If *H. mackenziei* was toxic, multiple documented cases of "accidental poisonings" would be expected, yet there are none to our knowledge.

Another telling point is the fact that there are no reports of native use of the plant. Alaskan Natives have a rich ethnobotanical history, and are well documented (Kari 1991, Viereck 1987) to have used death camus (*Zygadenus venenosus S. Watson*), seashore lupine (*Lupinus littoralis* Douglas ex Lindl), and baneberry (*Actaea rubra* (Aiton) Willd.) as medicinal agents or curatives. As far as we can tell, there has been no documented use of *H. mackenziei* by indigenous Alaskans.

Conclusions

In our initial studies, no chemical basis could be found to explain the toxicity of *H. mackenziei*, especially when compared against the edible *H. alpinum*. Additionally, there is no firm foundation for toxicity other than the accounts of a starving and desperate group of explorers

in the early 1800s, and no ethnobotanical uses have been documented. It is our belief that *H. mackenziei* is not toxic, and the reason for non-use of *H. mackenziei* lies simply in its morphology. The main tap root of this species is significantly smaller both in diameter and length than its more popular cousin *H. alpinum*, making it not worthwhile to dig it up from the rocky soil it inhabits.

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