Allelopathic properties of knotweed rhizome extracts

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ABSTRACT

Our objective was to determine which rhizome extract from Japanese knotweed, Giant knotweed or Bohemian knotweed has the most significant inhibition effect on the germinated seeds. The seeds of white mustard were incubated with the extracts for two days under laboratory conditions. We monitored differences in number of germinated seeds, length of radicles, hypocotyls and root/shoot ratio between the control and experimental seeds. Inhibitory effect of extracts from dried knotweed rhizomes was confirmed, but without differences among tested plants. A higher allelopathic effect was revealed in the case of extract from aboveground parts.

Keywords: allelopathy; phenolic compounds; germination; inhibitory effect; *Reynoutria*

It is known that knotweeds contain various phenolic compounds (Vrchotová et al. 2007). Dominant compounds of underground parts are mainly stilbenes (Vastano et al. 2000, Xiao et al. 2000, Yang et al. 2001, Chu et al. 2005), of aboveground parts quercetin derivatives and caffeic acid derivatives (our data, not published). Many of these phenols show biological activity or allelopathic abilities (Harborne 1993, Pietta 2000, Havsteen 2002).

We are interested in phenolic composition of all three knotweed species (Vrchotová et al. 2005, 2007). Thus the main aim of this paper was to disclose which rhizome extracts from three knotweed species have the most significant allelopathic properties influencing germinated seeds.

MATERIAL AND METHODS

Rhizome extracts from three knotweed species were used: Japanese knotweed (*Reynoutria japonica* Houtt.), Giant knotweed [*Reynoutria sachalinensis* (F. Schmidt) Nakai], and Bohemian knotweed (*Reynoutria* × *bohemica* Chrtek and Chrtková). Plant nomenclature was taken from Kubát et al. (2002).

The rhizomes of *R. sachalinensis* and *R. japonica* were collected in Slavkov near Český Krumlov and rhizomes of *R.* × *bohemica* in Český Krumlov on 26th August 2003 (both localities are in the South Bohemia region). All plant materials were obtained from 5 plants per one species and homologised. Rhizomes were dried under laboratory condition, mixed, and kept in an icebox. Two grams of dried material were melted with boiling distilled water, extracted for about 2 h, filtrated and used for experiments (volume of filtrated materials was 32 ml).

The seeds of white mustard [*Leucosinapis alba* (L.) Spach] were used as seed standard with 100% of germination. Seeds were incubated with the 6 ml extracts for 48 h under laboratory conditions (30 seeds per a culture plate, 4 repetitions). The seeds in control test were cultivated with 6 ml distilled water (control with 2 repetitions). All seeds were cultivated in darkness at 20°C. Percentage of germination, length of radicles, length of hypocotyls, and RSR (root/shoot ratio) were monitored after 48 h cultivation. Obtained data are shown in Table 1.

All data about increments were log transformed in order to obtain the normal distribution. Data evaluation was made with common statistical tests (Statistica 1999): *t*-test (differences in length of increments and RSR ratio between tested and control seeds), Tukey HSD test (differences in

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QH72117, and by the Grant Agency of the Academy of Sciences of the Czech Republic, Project No. AV0Z60870520.

Table 1. Investigated accretions for germinated seeds of white mustard incubated with the extracts from rhizomes of three knotweeds species (*Reynoutria* Houtt.)

Extracts	Radicle (mm)		Hypocotyle (mm)		Root/shoot ratio	
	test	control	test	control	test	control
R. japonica	4.87 ± 2.14	15.99 ± 6.96	1.98 ± 1.12	4.64 ± 1.89	2.87 ± 1.40	3.51 ± 1.32
R. sachalinensis	4.87 ± 2.14	15.97 ± 7.02	1.98 ± 1.13	4.64 ± 1.90	2.89 ± 1.62	4.67 ± 3.07
R. × *bohemica*	4.86 ± 2.16	15.97 ± 7.12	1.97 ± 1.13	4.61 ± 1.94	2.57 ± 1.31	4.67 ± 3.07

Means ± SD are given

length of increments and on RSR ratio among three types of extracts).

RESULTS AND DISCUSSION

Seed germination of white mustard under plant extract was slightly smaller than at the control plates (100%). Seed germination in extracts from Japanese knotweed was 97%, from Giant knotweed 96%, and from Bohemian knotweed 91%.

We found significant differences in the length of radicles, hypocotyls and on RSR ratio between the control and treated seeds (log transformation, *t*-test, $P < 0.05$). No significant differences were confirmed in the length of radicles, hypocotyls and on RSR ratio among extracts from all three knotweeds (log transformation, ANOVA, Tukey HSD test, $P < 0.05$). So, inhibitory effect of extract from dried knotweed rhizomes was without differences among tested species.

We supposed inhibitory effect of extract from underground parts to the seed germination, because knotweeds are aggressive perennial plants with extensive underground rhizomes (Bímová et al. 2004). Extract from the aboveground parts of knotweeds have a higher inhibitory effect to white mustard (Šerá et al. 2008, Vrchotová and Šerá 2008), than extract from rhizomes. Seed germination of white mustard under water extract from yellow autumn leaves of Japanese knotweed was 78%, from Giant knotweed 31%, and from Bohemian knotweed 67% (Šerá et al. 2008). The experiments with green summer leaves give similar data (Vrchotová and Šerá 2008). A lower inhibitory effect of knotweed rhizomes was surprising, because knotweeds prefer vegetative propagation and grow in compact one-species brushwood.

The rhizomes of three studied knotweed species probably differed among one another in the content of catechins and stilbenes. We do not suppose that these components may influence their allelopathic activity. The rhizome allelopathy is probably due to anthraquinones. Inoue et al. (1992) tested acetone extracts from Giant knotweed rhizomes on the *Lactuca* sp., *Amaranthus viridis* and *Phleum pratense* seeds. They determined that anthraquinones inhibit the growth of radicles and hypocotyls of treated seeds.

Contents of biologically active compounds in under- and aboveground parts of knotweeds are different both qualitatively and quantitatively. Anthraquinones inhibited the growth; however, we presume that knotweeds contain number of compounds with allelopathic properties.

Acknowledgements

The authors sincerely thank Václav Němec for his linguistic revision of the paper.

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Received on April 16, 2008

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