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Activity of Meadowfoam (*Limnanthes alba*) Seed Meal Glucolimnanthin Degradation Products against Soilborne Pathogens

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ABSTRACT: Meadowfoam (*Limnanthes alba* L.) is a herbaceous winter−spring annual grown as a commercial oilseed crop. The meal remaining after oil extraction from the seed contains up to 4% of the glucosinolate glucolimnanthin. Degradation of glucolimnanthin yields toxic breakdown products, and therefore the meal may have potential in the management of soilborne pathogens. To maximize the pest-suppressive potential of meadowfoam seed meal, it would be beneficial to know the toxicity of individual glucolimnanthin degradation products against specific soilborne pathogens. *Meloidogyne hapla* second-stage juveniles (J2) and *Pythium irregulare* and *Verticillium dahliae* mycelial cultures were exposed to glucolimnanthin as well as its degradation products. Glucolimnanthin and its degradation product, 2-(3-methoxyphenyl)acetamide, were not toxic to any of the soilborne pathogens at concentrations up to 1.0 mg/mL. Two other degradation products, 2-(3-methoxymethyl)ethanethioamide and 3-methoxyphenylacetonitrile, were toxic to *M. hapla* and *P. irregulare* but not *V. dahliae*. The predominant enzyme degradation product, 3-methoxybenzyl isothiocyanate, was the most toxic compound against all of the soilborne pathogens, with *M. hapla* being the most sensitive with EC_{50} values (0.0025 ± 0.0001 to 0.0027 ± 0.0001 mg/mL) 20−40 times lower than estimated EC_{50} mortality values generated for *P. irregulare* and *V. dahliae* (0.05 and 0.1 mg/mL, respectively). The potential exists to manipulate meadowfoam seed meal to promote the production of specific degradation products. The conversion of glucolimnanthin into its corresponding isothiocyanate should optimize the biopesticidal properties of meadowfoam seed meal against *M. hapla*, *P. irregulare*, and *V. dahliae*.

KEYWORDS: *nematicidal effect, fungicidal effect, lethal concentration, seed meal*

INTRODUCTION

Meadowfoam (*Limnanthes alba* L.) is a herbaceous winter−spring annual grown as a commercial oilseed crop. In the Willamette Valley of Oregon, meadowfoam fills an important niche as a winter rotation crop in grass seed production systems. In 2010, approximately 4000 acres of meadowfoam was grown in Oregon with a value of $2 million.[1] Research and development of meadowfoam began in the late 1950s, and commercial development began in 1980.[2] When harvested, meadowfoam seeds contain 20−30% oil rich in rare long-chain 20:1 and 22:1 fatty acids.[3] Meadowfoam's unique chemical properties, which impart a high degree of stability, make it especially suitable for use in cosmetic products. After the oil has been extracted from the seeds, the seed meal constitutes approximately 70% of harvested crop yield; current commercial outlets for this byproduct are limited.

Meadowfoam seed is unique among oilseeds in that it contains several classes of plant secondary metabolites including the glucosinolate glucolimnanthin[4] and minor amounts of rutin and phytoecdysteroids.[5] When meadowfoam seed is physically damaged and exposed to moisture, glucolimnanthin **1** readily degrades to toxic breakdown products such as 3-methoxyphenylacetonitrile (also referred to as 3-methoxybenzyl cyanide; nitrile **2**), 3-methoxybenzyl isothiocyanate (isothiocyanate **3**), 2-(3-methoxyphenyl)-ethanethioamide (thioamide **4**), and 2-(3-methoxyphenyl)-acetamide (acetamide **5**) (Figure 1). This conversion is mediated by the glucosinolate-degrading enzyme myrosinase.[4] To prevent myrosinase activity during the oil extraction process, seeds are heat treated to inactivate myrosinase, thereby leaving the seed meal byproduct devoid of the active enzyme.

Degradation products from glucolimnanthin **1** are known to have biopesticidal properties. The degradation products isothiocyanate **2** and nitrile **3** inhibited radical elongation of velvetleaf (*Abutilon theophrasti*) and wheat (*Triticum aestivum*).[6] Production of isothiocyanate **2**, nitrile **3**, and thioamide **4** from fermented meadowfoam seed meal correlated with increased herbicidal activity of the seed meal against downy brome (*Bromus tectorum*).[7] Isothiocyanate **2** was toxic to fall armyworm (*Spodoptera frugiperda*) larvae and European corn borer (*Ostrinia nubialis*), whereas nitrile **3** was not.[8] Meadowfoam seed meal has also been shown to reduce the severity of clubroot of cauliflower caused by *Plasmodiophora brassicae*.[9] However, the active principles responsible for this suppression were not identified in that study. The effect of meadowfoam seed meal on plant-parasitic nematodes and other soilborne plant pathogens has not been investigated, yet there is evidence from research on other glucosinolate-containing brassicaceous

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