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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Assessment of allelopathic potential and the growth inhibitory substances in Thai forest plants for the development of bioherbicides (植物由来の除草剤開発を目的としたタイの森林植物が有するアレロパシーの可能性およびその生長抑制物質の評価)

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Many forest trees possess allelopathic properties and release a wide variety of allelopathic compounds against other organisms that make remarkable impacts on the components of the ecosystem, including the plant community. The inhibitory potential of allelopathic plants currently receives much attention to apple them as a tool for weed management in sustainable agriculture. The crude extracts or plant residues of the allelopathic plants can be directly applied as bioherbicides, while the compounds isolated from the allelopathic plants can be used as templates for developing natural herbicides. Therefore, screening allelopathic species and identifying the growth inhibitory compounds with a high allelopathic activity could augment current weed control approaches. Hence, the present study assessed the allelopathic potential of three forest plants, namely *Dalbergia cochinchinensis* Pierre., *Afzelia xylocarpa* (Kurz) Craib., and *Senna garrettiana* (Craib) Irwin & Barneby and the compounds responsible for their phytotoxicity.

The aqueous methanol leaf extracts of *D. cochinchinensis*, *A. xylocarpa*, and *S. garrettiana* exhibited significant inhibition on the seedling growth of dicotyledonous plants; lettuce, cress, and alfalfa, and monocotyledonous plants; barnyard grass, Italian ryegrass, and timothy. In addition, concentration- and species-dependent inhibitory activities of three extracts were found on the shoot and root length of test plant species. Three extracts were completely (100%) inhibited seedlings of all test species at the concentration of 300 mg of dry weight equivalent extract/mL, except the shoot length of barnyard grass and Italian ryegrass. Based on the concentration required for 50% growth inhibition (IC_{50} value) of all the extracts, *D. cochinchinensis* extracts had greater inhibitory activity on test plants than those of the extracts of *A. xylocarpa*, and *S. garrettiana*, with values in the range

between 1.0 to 68.67, 7.8 to 31.1 and 12.4 to 32.2 mg dry weight equivalent extracts/mL, respectively. The inhibitory activities of those plant extracts suggest that the plants may possess allelopathic potential and contain inhibitory substances.

The inhibitory substances in aqueous methanol leaf extract from *D. cochinchinensis*, *A. xylocarpa*, and *S. garrettiana* were isolated using several chromatographic steps. The chemical structures of the substances were identified by APCIMS, HRESIMS, ^{1}H- and ^{13}C NMR. Protocatechuic acid was isolated from *D. cochinchinensis* leaf extracts. Eight compounds were isolated from the *A. xylocarpa* leaf extracts and identified as vanillic acid, *trans*-ferulic acid, (+)-dehydrovomifoliol, (3*R*,6*R*,7*E*)-3-hydroxy-4,7-megastigmadien-9one, (+)-3-hydroxy-β-ionone, (*S*)-*N*-(1-hydroxy-3-phenylpropan-2-yl) benzamide, isololiolide, and (+)-lariciresinol. On the other hand, five compounds were isolated from *S. garrettiana* leaf extracts and identified as vanillic acid, ferulic acid, caffeic acid, methyl caffeate, and (*S*)-6-hydroxymellein.

Fourteen isolated compounds at different concentrations were determined for their activity against the cress seedlings. All isolated compounds significantly suppressed the hypocotyl and root length of the cress to different extents. As the concentration of the compounds increased, the seedling growth of cress was significantly reduced. Considering IC_{50} values of isolated compounds, isololiolide (IC_{50} = 53 to 115 µM) had the highest inhibition on cress seedlings followed by (+)-3-hydroxy-β-ionone (IC_{50} = 227 to 273 µM), (*S*)-6-hydroxymellein (IC_{50} = 383 to 475µM), ferulic acid (IC_{50} = 620 to 710 µM), *trans*-ferulic acid (IC_{50} = 650 to 760 µM), and the other compounds (IC_{50} = 820 to 7560 µM). Moreover, the results also showed the cress roots were the most susceptible to eleven isolated compounds, whereas *trans*-ferulic acid, ferulic acid, and methyl caffeate had the greatest effects on the cress hypocotyls than their roots.

In conclusion, the leaf extracts of *D. cochinchinensis*, *A. xylocarpa*, and *S. garrettiana* showed inhibitory activity on seedling growth of monocotyledons and dicotyledons, which indicates those plants may have allelopathic potential and contain the growth inhibitory substances. Fourteen inhibitory compounds were isolated from three plant extracts, all of which affected the hypocotyl and root length of cress at different levels. Such inhibitory effects indicate that these isolated compounds may contribute to the allelopathic potential of *D. cochinchinensis*, *A. xylocarpa*, and *S. garrettiana* leaves. To the best of my knowledge, this study was the first attempt of finding out the allelopathic activity of these forest plants and their compounds. Therefore, these findings suggest that the leaf residue of three forest plants could be potentially applied as soil additive materials for weed management options in sustainable agriculture. Their growth inhibitory compounds could serve as natural sources for developing future bioherbicides.