

学位論文要旨

Evaluation of the allelopathic potential of medicinal plants used in Ghana and the identification of carnosic acid as a phytotoxic compound in *Rosmarinus officinalis*

ガーナで利用されている薬用植物のアレロパシー活性の評価と
ローズマリーに含まれるカルノシン酸の植物生育阻害物質としての同定

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Weeds are rapidly developing resistance to synthetic herbicides, and this can pose a threat to the ecosystem. There is however, the need to develop new or improve existing weed control strategies to mitigate the threat of rising herbicide-resistant/tolerant weeds. Plants produce various secondary metabolites that may have numerous biological functions when released into the environment. Allelopathy is a phenomenon whereby plants release bioactive substances that influence (inhibition or stimulation) other plants in the environment. Exploring allelopathic species as an alternative weed control measure can help minimize the ecological threat posed by herbicide-resistant weeds. Medicinal plants have become a resource target for identifying various bioactive substances, including allelochemical. Several studies on the *in-vitro* activities of medicinal plants used in Ghana have been reported. The main objectives of this study were to: a) document medicinal plants used in some parts of

Ghana and evaluate their potential allelopathic potentials, b) identify allelochemical responsible for the plant growth inhibitory activity of candidate species, and c) assess the effects of season variations on the plant growth inhibitory activity of the candidate allelopathic plant.

An ethnobotanical survey was conducted in the Ejisu-Juaben Municipality to identify and document medicinal plants and their uses through a questionnaire. Statistical tools and ethnobotanical indices, i.e., informant consensus factor (ICF), fidelity level (FL), and use value (UV) were used to analyse the data. One hundred and six (106) medicinal plants belonging to 45 families were reported. The most frequently used plant part in this study was the leaves (52%). *Cleistopholis patens* and *Ocimum gratissimum* had the highest UV (0.54 and 0.37 respectively) among all the documented species. Subsequently, 244 plant samples from 188 medicinal plants used in Ghana were evaluated for potential allelopathic species using the Sandwich, Dish pack, and Plant box bioassay methods for allelopathy through leachates, volatiles, and exudates respectively. The species evaluated included plants recorded from the survey and species from other research centres. Rosemary (*Rosmarinus officinalis* L.) showed potential plant growth inhibitory through all the three major routes of allelochemical release. The inhibition on lettuce radicle elongations was 6.5%, 9.9%, and 29% of control for rosemary leachates volatiles and exudates respectively. Other species that showed potential plant growth inhibitory activity were *Bridelia micrantha* Baill. and *Xylopia aethiopica* A.Rich. The relationship between ethnobotanical indices and allelopathic activities of medicinal plants were studied. There was a significant positive correlation (Pearson) between the UV and RFC of medicinal plants and allelopathy by leaf leachates ($r = 0.639$ **, $p < 0.01$ and $r = 0.653$ **, $p < 0.01$ respectively). The phytotoxicity of *R. officinalis* was further investigated since the plant showed the highest potential plant growth inhibitory activity against lettuce. The crude extract of *R. officinalis* leaves caused the highest inhibition on lettuce radicle growth, followed by the inflorescences, stems, and roots. Soil amended with *R. officinalis* leaf debris reduced the dry matter and seed emergence of lettuce. Carnosic acid was the main compound detected in rosemary leaves and had a high specific activity when tested on lettuce. During the seed germination period, there was observed filter paper coloration among the test plants treated with carnosic acid (250 µg/mL). The high concentration and strong inhibitory effect of carnosic acid could explain the inhibitory activity of the rosemary leaf extract. Carnosic acid was confirmed to be the principal allelochemical involved in the inhibitory activity of *R. officinalis* leaves. Furthermore, the place of collection of rosemary leaves significantly affected the content of carnosic acid, which subsequently influenced the phytotoxic effect on lettuce. The seasonal variations also influenced the content of carnosic acid and inhibitory activity of rosemary leaves.

In conclusion, rosemary and other selected candidate allelopathic plants (*Bridelia micrantha* and *Xylopia aethiopica*) were identified from the initial screening for allelopathic species. The leaves of rosemary showed high inhibitory activity, and carnosic acid was shown to be principal allelochemical responsible for the growth inhibitory activity. The plant growth inhibitory activity of rosemary leaves are affected by seasonal variations with influence from rainfall and temperature.

Keywords: Allelopathy, Carnosic acid, Ethnobotany, Inhibition, *Rosmarinus officinalis*.