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Eco-friendly weed control: herbicidal potential of *Achillea millefolium* essential oil

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Extensive reliance on synthetic herbicides became a significant concern, with implications for human health and the environment. Furthermore, the increasing development of resistance among weed species has reduced the effectiveness of traditional herbicide treatments. Consequently, plant-derived compounds are increasingly being explored as natural alternatives for pest and weed management, mainly due to their selectivity, biodegradability into non-toxic products and minimal impact on non-target organisms and ecosystems [1] [2]. This study aimed to: i) analyze the phytochemical profile of *A. millefolium* essential oil (EO); ii) evaluate its potential phytotoxic effects on the seeds of *Sinapis arvensis* L., *Hordeum vulgare* L., *Raphanus sativus* L. and *Lolium multiflorum* Lam.; iii) extract and evaluate α -amylase activity from treated seedlings to investigate a possible correlation between phytotoxicity and anti-amylase activity; iv) evaluate ecocompatibility through *Artemia salina* assay; v) explore antimicrobial properties against some bacterial and fungal

phytopathogenic strains. Chemical composition analysis conducted by GC-MS identified 69 compounds, with oxygenated monoterpenes as the dominant group, including borneol (12%), camphor (11.5%) and 1,8-cineole (8.9%). EO demonstrated phytotoxic effects on seed germination and seedling growth, particularly against *S. arvensis*. Subsequent to the phytotoxic activity, a reduction in the α -amylase activity extracted from the seeds was observed, suggesting a possible correlation between the two activities. Furthermore, EO was not toxic on *Artemia salina*, suggesting its potential as a safe bioherbicide. EO also showed antimicrobial activity against *X.campestris* and *P.italicum*. These results highlight the potential of *A. millefolium* EO as a natural herbicide and antimicrobial agent, offering an environmentally friendly alternative for sustainable agriculture.

References

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