Journal of Plant Diseases and Protection (2023) 130:439–441
https://doi.org/10.1007/s41348-023-00739-3

EDITORIAL

Botanical active substances: a prospering field of research

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Published online: 25 April 2023

Since months, the Journal of Plant Diseases and Protection receives a rising number of submissions concerned with the search for alternatives for chemically synthetic pesticides. In the centre of interest are simple plant extracts including botanical active substance like essential oils for use in plant protection.

The term 'botanical active substance' covers an extremely heterogeneous group of substances ranging from simple plant powders to unprocessed and processed plant extracts. Furthermore, plant extracts may be highly refined (i.e. one single active substance) or represent a complex mixture of components of which all or only some are biologically active.

This topic collection focuses on botanicals in plant protection, particularly natural plant extracts and essential oils. These active substances have gained popularity as alternatives to chemical–synthetical pesticides, as they are assumed to offer benefits like low toxicity and environmental compatibility for sustainable agriculture. The collection includes 12 selected papers from different countries summarizing recent studies on the effectiveness of natural products in controlling pests and diseases of economically important food crops in agriculture, as well as their potential use in systemic acquired resistance and reducing pesticide residues.

Substances referred to as analogues, mimics, natural-identical synthesised molecules and biosimilars are not covered by these research reports. This shows that we might be at the beginning of a development not to explore botanical actives as resource for industry but for direct use by farmers as self-preparations.

The issue starts presenting the European Union legislative situation on the use of botanicals in plant protection. Regulation (EC) No. 1107/2009 requires evaluation and authorization before any substance can be marketed as an active ingredient in a plant protection product. This regulation does not cover botanical extract which are produced by farmers and used directly on the own field without being placed on the market as a plant protection product.

In the articles published here but in former issues also, a 'botanical active substance' consists of one or more components found in plants and obtained by subjecting plants or parts of plants of the same species to a process such as pressing, milling, crushing, distillation and/or extractions. The process may include further concentration, purification and/or blending, provided that the chemical nature of the components is not intentionally modified/altered by chemical and/or microbial processes.

The authors reported pesticide properties of plant extracts, essential oils, plant-derived powders and other natural or processed plant derived materials as potential insecticide, acaricide, molluscicide, rodenticide, fungicide, antiviral, herbicide or resistance inducers in plant protection. Repellency and antifeedant characteristics of botanical substances and the potential use in plant protection programs were described, even allelopathic effects were also discovered.

Exemplarily, the use of botanical substances was matter of these studies:

- Stored-product pests cause significant economic losses, and essential oils have been identified as potential alternatives to chemical–synthetical pesticides due to their potential low toxicity, e.g. on humans and non-target organisms, as well as on the environment. In this scenario, a review of effective essential oil components in stored-product pest management aims to provide a com-

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prehensive summary of their insecticidal properties along with the potential mode of action.

- The insecticidal activity of two *Eucalyptus* essential oils against the Mediterranean fruit fly, *Ceratitis capitata*, highlights the potential of natural products to control key insect pests. Similarly, a study on the Tine-Djebbar lesser grain borer, *Rhyzopertha dominica*, shows that essential oils could be used as alternative insecticides to synthetical chemicals. Tannin extracts from processed *Camellia sinensis*, *Vicia faba*, and *Urtica dioica* have potential insecticidal properties, while *Allium cepa* essential oil showed weak insecticidal activity against important pests of agricultural crops. The ovicidal and residual effects of *Moringa oleifera* ethanol leaf extract on *Tetranychus merganser* demonstrate the strong potential of natural active substances in controlling spider mites. The chemical composition and insecticidal activity of *Ocimum basilicum* essential oil and its major constituent, estragole against *Sitophilus oryzae*, highlights their potential as botanical insecticides against a major pest of stored grains. Fungal metabolites derived from two entomopathogenic fungi, *Cladosporium cladosporioides* and *Acremonium zeylanicum*, were identified, and the constituents have strong insecticidal activity potential against several insect species and could be used as alternative insecticides.
- Botanical extracts can induce systemic acquired resistance in rice plants, providing long-term protection against *Rhizoctonia solani*, the cause of rice sheath blight, a major disease affecting rice crops worldwide. Several substances were investigated for their potential in controlling powdery mildew, a major disease of roses caused by *Podosphaera pannosa*. Studies have also explored the potential of chitosan, a basic substance, in managing fungal diseases such as *Podosphaera pannosa* on cutting roses and *Erysiphe polygoni* on *French hydrangea*. These studies have examined the efficacy of chitosan-based treatments in controlling these plant diseases, as well as the potential mechanisms underlying this efficacy. The findings suggest that chitosan and other substances may be a promising tool for managing fungal diseases in horticultural settings.
- The bioefficacy of pumpkin (*Cucurbita pepo*), sage (*Salvia officinalis*), and sesame (*Sesamum indicum*) essential oils was evaluated as defence inducers against rust disease in faba bean. The study found that pumpkin oil proved more efficient and can be considered as an effective fungicide against rust disease threatening faba bean.

The next level studies of botanical substances for use in plant protection are not yet often reported:

Behavioural effects of botanical substances, the host plant metabolites, on interspecies interactions, side effects of botanical pesticides on non-target organisms including natural enemies and pollinators, formulations and standardizations of botanical active substances (with appropriate pesticide, repellency, antifeedant, resistance induction and other properties) for applying in farm, greenhouses, or silages, integrating the botanical active substances and other control strategies, e.g. biological control using predators, parasitoids and microbiological agents, for enhancing sustainable pest control, physiological effects, e.g. insect growth regulating effects of botanical substances, screening the best active constituents causing desired effects on the pests or plant diseases for introducing novel chemical pesticides, repellents, etc., and finally, economic importance and popularity of the botanical substances in plant protection among farmers and costumers and their roles for developing products for organic agriculture should be addressed in future analyses.

As responsible associate editors of JPDP, we would very much appreciate if further submissions of this obviously prospering field of research would include the following information: The pathogen/host plant combinations, the impact of the diseases or pest and the current situation of pesticide use should be described, the state of the art of use of the specific botanical active substance studied, including the availability of the plant materials should be described, the method of preparation and processing should be described or referenced, any information concerning variability of plant material and extract should be provided, the mode of action should be commented or shown, the practical relevance should be discussed on the basis of efficacy data; the Technology Readiness Level (TRL) should be highlighted, the local, regional or global usefulness described, data of efficacy in comparison with standard pesticides used are required, the discussion should avoid general statements like "might be used for plant protection"; instead, clear visions on technological transfer or next steps of development should be pointed out.

The JPDP continuously welcomes submissions on this important aspect of plant protection and expects a development on this field research in direction to reproducible and transferable plant production strategies as component of integrated plant protection.

Funding Open Access funding enabled and organized by Projekt DEAL.