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## Summary

### „Evaluation of the sensitivity of polyphagous *Fusarium* fungi on essential oils”

Filamentous fungi of the *Fusarium* genus belong to the polyphagous, optional parasites of plants that can also attack human and animal organisms. The growing phenomenon of acquiring resistance to fungicidal substances by these fungi, their high pathogenicity and strong toxicity cause that new, safe substances are being sought to inhibit their development.

Many scientific reports indicate the effectiveness of essential oils in reducing the development of phytopathogenic fungi but this information is not strictly related to the chemical composition of essential oils and their fungicidal activity and does not take into account the possibility of using them as seed treatments. The research being the subject of this work is an attempt to explain these relationships.

In the study a research hypothesis was proposed that the fungicidal action of essential oils in concentrations up to 2% on fungi of the *Fusarium* genus may depend on the chemical composition of tested essential oils, particularly on the chemical compounds that dominate in them. This will facilitate the selection of essential oils that inhibit the development of *Fusarium* fungi in the natural environment.

The aim of the work was to assess the sensitivity of polyphagous fungi of the *Fusarium* genus on the basis of changes in their morphological characteristics, such as the growth and colouring of mycelium and spore germination in the presence of essential oils of various chemical composition and concentration. The use of allelopathic potential at low concentrations of essential oils effectively inhibiting the development of phytopathogens of the *Fusarium* genus in order to assess the germination capacity of infected wheat caryopses.

The research material consisted of nine phytopathogenic fungal isolates of the genus *Fusarium* isolated from infected caryopsis wheat in Germany (*F. graminearum* ZALF 24, *F. graminearum* ZALF 339, *F. culmorum* ZALF 186, *F. culmorum* ZALF 187 and *F. poae* ZALF 338) and in Poland (*F. graminearum*, *F. culmorum*, *F. oxysporum* and *F. avenaceum*). Eight essential oils such as: thyme, lemongrass, *Litsea cubeba*, verbena, tea tree, cajeput,

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garlic and grapefruit at concentrations of 0.025; 0.05; 0.125; 0.25; 0.50; 1.0 and 2.0% and a chemical preparation Funaben T acting as a relative control of the effectiveness of essential oils were tested. The seed was spring wheat of Katoda type (*Triticum aestivum* L.) originating from the Plant Breeding Company "DANKO" in Choryń.

The isolated fungi were marked to the species on the basis of macro - and microscopic features parallel in the laboratory of Independent Department of Biotechnology and Molecular Biology at University of Opole, Zentrum für Agrarlandschaftsforschung ZALF e.V. in Leibniz and Institute for Landscape Biogeochemistry Biologist in Müncheberg while the species identification of the most sensitive isolates was confirmed by a molecular research carried out in Bionicum Company Sp. z o.o. in Warsaw.

The chemical composition of tested essential oils was determined by means of gas chromatography coupled with GC/MS mass spectrometry. The research was carried out in two stages.

The first stage assessed the effect of low concentrations of essential oils on:

- mycelium growth of *Fusarium* isolates based on the growth rate index
- fungistatic activity of the tested oils based on the growth inhibition factor [%]
- spores germination of *Fusarium* isolates based on spore germination index.

The minimum fungicidal concentration (MFC) of the most effective essential oil was also determined.

The second stage of the research included the use of allelopathic potential of low concentrations of essential oils effectively inhibiting the development of phytopathogens of the *Fusarium* genus in order to assess the germination capacity of infected Katoda spring wheat caryopses. It consisted in an evaluation of:

- energy and germination capacity of wheat caryopses
- direct action of oil solutions on the development of wheat seedlings and reduction of infection degree of seedlings by phytopathogens (vase plant tests)
- carriers for the construction of antifungal seed dressing based on the essential oil of the highest fungicidal activity
- the influence of thyme oil on the growth of wheat seedlings artificially inoculated with *Fusarium* fungi using the Microbiotest - Phytotoxkit from MicroBio Tests Inc.

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An attempt was made to establish the relationship between the chemical composition of essential oils, particularly on the chemical compounds that dominate in them and fungicidal activity in relation to all the tested *Fusarium* isolates.

The susceptibility of nine polifagic isolates of the *Fusarium* genus originating from different environments varied and depended on the type and concentration of the tested oils. The effect of biological action of essential oils was a complete or partial inhibition of both the development of mycelium and spores germination as well as the change in pigmentation of mycelium which is associated with fungal strain susceptibility.

The tested isolates showed the highest susceptibility at low concentrations of oils whose main component are terpenoid compounds (thyme oils, lemongrass and *Litsea-cubeba*), the lowest was for monoterpenes, which are the main component of grapefruit oil and organic sulfur compounds found in garlic oil.

The fungicidal activity of the oils depended on the chemical compounds that were dominant, such as: thymol (thyme oil) showing lethal properties from concentration of 0.05%,  $\alpha$  and  $\beta$  citral (lemongrass, *Litsea cubeba* and verbene oil) from concentration of 0.125%, 1 - terpineol (tea tree oil) from concentration of 0.5%,  $\alpha$  - terpineol (cajeput oil) from concentration of 1.0% and organosulphur compounds and limonene (garlic and grapefruit oil) from concentration of 2.0%. The development of tested *Fusarium* isolates (with the exception of Polish isolate *F. oxysporum*) was completely inhibited by thyme oil only regardless of concentration used. *F. oxysporum* isolate was insensitive at the lowest concentration used (0.025 - 0.05%) of this oil. Thyme oil at concentrations of 0.05% and 0.125%, in a similar way to Funaben T seed dressing, effectively protected seedlings against fungi of the genus *Fusarium*. Effectiveness of thyme oil in concentrations: 0.025; 0.05 and 0.125% strengthened immobilization with the carrier, which constituted 1.5% of sodium alginate with calcium chloride. Energy and germination capacity of Katoda wheat caryopses were then over 85%. The conducted research confirms the assumed hypothesis that the fungicidal action of essential oils in concentrations up to 2% on fungi of the genus *Fusarium* depends on the chemical composition of tested essential oils, particularly the chemical compounds that dominate in them and it can be used to construct seed treatments.

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