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Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project: Odorant Degrading Enzymes as molecular targets for controlling the olive fruit fly's behavior

Principal Investigator: Christina E. Drakou

Reader-friendly title:

Scientific Area: Agricultural Sciences – Food Science and Technology – Agricultural Biotechnology

Institution and Country: Hellenic Foundation for Research and Innovation, Greece

Host Institution: Department of Biochemistry and Biotechnology, University of Thessaly

Budget: 170.000 €

Duration: 36 months

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Research Project Synopsis

Infestation of olive orchards by *Bactrocera (Dacus) oleae* remains a huge socioeconomic problem despite all efforts to combat it. Conventional means to eradicate infestation have serious adverse health and environmental effects. Insects rely on olfaction for their survival and reproduction by following pheromones and odorants to find mating partners, food sources and oviposition sites. Thus, targeting the insect olfactory system is a suitable means for the development of safer and eco-friendly methods. The insect olfactory system is very complex and it is only recently that several aspects started to emerge. The main mechanism of the olfactory system involves binding of an odorant molecule by the odorant binding proteins (OBPs) which transfer it to the odorant receptors (ORs). Binding to ORs generates a signal to elicit insect behavior. Odorant degrading enzymes (ODEs) decompose odorant molecules clearing the olfactory system to accept new odors. Antennal specific ODEs represent the first step in pheromone and odorant degradation playing a crucial role in clearing the background noise and tune insect behavior.

The structure-based discovery of insect behavioral disruptors, based on the elucidation of the structure-function relationship of olfactory components, has been proposed as a novel and rational approach to combat crop infestation. The aim of the project is to determine the 3D structure at atomic resolution of three ODEs and their binding site(s) providing the means of *ab initio* discovery of inhibitors of the insect olfactory system, thus leading to the prevention of infestation of olive orchards. Hence, the overarching goal of the project is to elucidate the molecular mechanisms of odorant degradation in insects, paving the way for the discovery of novel methods to be implemented in an integrated pest control management program.

Project originality

Previous functional studies regarding OBPs and ORs led to the discovery of high-efficiency pest repellents and attractants. Structural studies on OBPs revealed their binding sites and properties and paved the way for structure-based approaches for the discovery of new compounds. However, similar studies on ODEs are scarce and several ODEs from different insect species have been identified. ODEs belong to different classes of enzymes that are crucial in the breakdown of odors and pheromones to detoxify the olfactory system of insects. They are expressed in the antennae of insects and are categorized not only based on their enzymatic character but also their role in the olfactory system. Given that the rapid degradation of redundant odorants increases the sensitivity of the olfactory system, the role of insect ODEs that are highly expressed in the chemosensory in odorant degradation and behavioral control system should be elucidated, to guide to novel ways of insect pest control.

The innovative goal of the project is to discover ODE inhibitors to control *B. oleae* behavior and to disrupt its infestation on olive orchards. The major advantage of targeting ODEs over OBPs or ORs lies with the fact that odors are perceived as precise mixtures, and therefore inhibiting the decomposition of a specific component (by inactivating a specific ODE) will alter the composition of each odorant mixture captured by the insect, resulting in the misconception of any odorant and the blocking of the entire olfactory mechanism affecting insect behavior. Furthermore, ODEs' broad specificity for odorant molecules, provides the advantage to inhibit the decomposition of a variety of molecules by inhibiting a single ODE enhancing thus the effectiveness of the selected approach.

Expected results & Research Project Impact

The project is expected to contribute significantly to the understanding of the molecular mechanism of the olfactory system of insects, providing the first three-dimensional structures of three ODEs of the olive fruit fly and therefore the structural basis of odor degradation in the olfactory system. The structural and biochemical study of their bioactivity against a number of volatile olive compounds will clarify the interactions governing the molecular recognition of these three ODEs. The knowledge generated will guide further studies to discover new environmentally friendly means of disrupting the infestation of olive orchards. This will be achieved by inhibiting ODEs with special inhibitors, thus flooding the olfactory system with molecules that will create sufficient "noise" to recognize any odor by completely deactivating the olfactory system. Deactivation of the olfactory system can lead to (a) the reduction of oviposition and (b) the reduction of the mating frequency of the insects and consequently the infestation of the olive trees.

The importance of this funding

The HFRI funding, in addition to the prestige and recognition it brings, improves career prospects for young scientists, promotes productive academic collaborations and generates novel scientific information. Insect's olfactory system is an important target for the discovery of novel pest management means and has been the focus of research interest in the last years. Several laboratories work on this subject and every year a large number of high impact factor publications are produced. This funding helps to establish myself as a researcher on the insect olfactory system field providing me with the necessary potential to develop my independent research in the agrobiotechnology sector in high prestigious universities and research centers in Greece and other European countries.

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