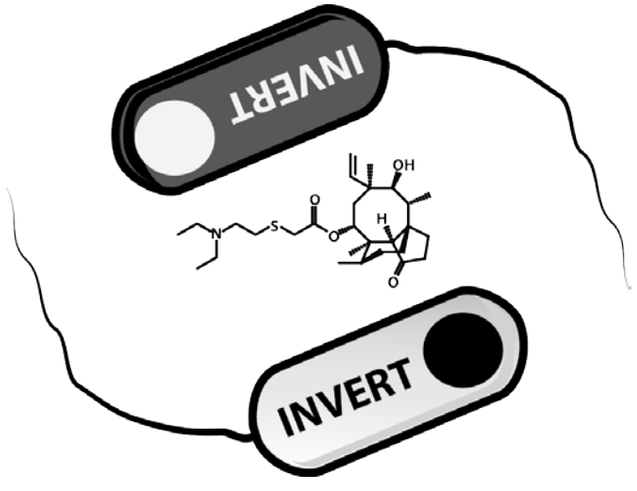
H.F.R.I.
Hellenic Foundation for Research & Innovation

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:
INteractions of Veterinary antibiotics with soil microorganisms: exploiting microbial degradation to avert Environmental contamination and ResisTance dispersal



Principal Investigator: Sotirios Vasileiadis

Reader-friendly title: INVERT

Scientific Area: Agricultural Sciences - Food

Institution and Country: University of Thessaly, Greece

Host Institution: University of Thessaly

Collaborating Institution(s): Hellenic Agricultural Organisation-Demeter,INRA / AGROECOLOGIE CENTRE DE DIJON, Aristotle University of Thessaloniki

Budget: 170,000 €

Duration: 32 months

Project webpage: http://invert.bio.uth.gr

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Research Project Synopsis

Veterinary antibiotics (VA) control microbial infections in livestock farming. VA are not particularly metabolized in vivo in animals and they are excreted in urine and feces. These are used as manures facilitating the dispersion of VA residues to agricultural soils. This practice entails risks for the environment and public health since it (a) imposes pressure on the soil microbial community for selection of antibiotic resistant traits and (b) facilitates the translocation of VAs to natural water resources and plants (edible parts). However, recent studies showed that the continuous soil exposure to certain VA groups selects not only for antibiotic resistance but also for VA-degrading microbes which utilize VA as C and/or N sources. The project aims to shed light in the complex interactions of VA with soil microorganisms, INVERT (project acronym) the outcome of the environmental pressure imposed by VAs on the soil microbial community from negative (selection for resistance) to beneficial (selection for energy-gain biodegradation of VA) and exploit growth-linked biodegradation to reduce environmental exposure to VA. In this quest, we will focus on understudied VAs which are heavily used in Greek livestock farming, like ceftiofur and tiamulin, plus a sulfonamide, considered as biodegradable VA. In particular INVERT will (i) explore multiple aspects (ecotox/resistance biodegradation) of the interactions between VA and soil microorganisms (ii) isolate VA- degrading bacteria using VA as an energy source and identify the respective genetic mechanisms and transformation pathways (iii) explore the role of the soil mobilome in the evolution of VA resistance and biodegradation traits (iv) evaluate the use of VA-degrading isolates in the bioaugmentation of contaminated manures. The achievement of project goals will provide benchmarking knowledge on the interactions of VA with soil microorganisms and reduce VA environmental levels benefiting the environment and public health.

Project originality

The project is going to investigate a serious environmental problem, the dispersal of VA and microbial resistance determinants via agricultural use of manures, using a holistic approach whose novel aspects will:

- shed light into the complex interactions between VA and soil microorganisms using a multi-discipline approach covering aspects which have been largely ignored. The main focus of most studies to date has been on the dispersal and evolution of microbial VA resistance traits due to VA selective pressure on soil microbial communities. However, the evolution of energy-gain catabolic traits associated with the enhanced biodegradation and detoxification of VA in soil have attracted less attention which is the main focus of the current project.

- explore the contribution of MGE on the evolution of VA resistance and chromosomally encoded energy-related VA biodegradation mechanisms. The project will go a step beyond the currently employed approaches and use a combination of advanced omic methods to explore the role of the soil mobilome on the dispersal and evolution of VA resistance and energy-gain biodegradation capacities by the soil microbial community.

- exploit the biodegradation potential of exposed agricultural soils and use them as a source for the isolation of VA-degrading microorganisms and the utilization of the latter as sources of nutrients like C, N, S.

- systematically characterize the genetic mechanisms driving the growth-linked biodegradation capacity of the isolated VA-degrading soil bacteria with state-of-the-art omic methods.

- shed light into the evolutionary relation between VA resistance and growth-linked biodegradation phenotypes in soil bacterial isolates degrading VA.

- evaluate and, if successful, implement novel bio-based approaches for the remediation of VA-contaminated manures.

Expected results & Research Project Impact

The project is expected to have a major impact on science, economy and the society in large:

- will have a major scientific impact since it will (i) generate novel knowledge on the environmental behaviour of understudied VA and explore their off-target impact on soil ecosystem functioning; (ii) isolate novel VA-degrading bacteria which use VA as energy source, and identify tassociated mechanisms; (iii) determine the microbial transformation pathway of novel VA using advanced omic tools; (iv) assess potential evolutionary links between resistance and energy- gain biodegradation of VAs; (v) exploit those isolates for the detoxification of VA-contaminated manures.

- will have a major impact on the EU regulatory VA framework. Currently, environmental risk assessment of VA is based on existing guidelines of other chemicals largely overlooking their impact on off-target soil microorganisms. It was recently proposed that microbial community-based tests should be used to offer a more targeted protection of key ecosystem services. The project will assess the impact of VA on the function and the diversity of soil microorganisms using advanced and standardized tools. This could benchmark the incorporation of a novel environmental risk assessment scheme which will guarantee the safer use of VA at EU level and beyond.

- will directly impact economy: (a) It will lead in a reduction in the environmental VA levels alleviating selective pressure toward microbial antibiotic resistance. Thus, resulting in substantial reduction of VA use and livestock production costs; (b) It will lead to the development of innovative biotechnological products (i.e. VA-degrading bacterial inocula/enzymes) and their market exploitation.

- will stimulate public awareness on serious environmental and public health uses stemming from antibiotics misuse and unorthodox agricultural practices.

The importance of this funding

In general, HFRI actions offer strong support for performing global level research and empowers researchers of the Greek Academia and Research Institutes to achieve excellence and to place the Greek institutes among other top EU institutes. To this end, it will allow me and my institute to solidify existing, and develop new collaborations with highly competent and influential institutions and researchers, that will allow our improvement and continuity in our high impact research. Finally, this funding will comprise the basis for taking a step further in research. It will provide the necessary basis for training postgraduates in state-of-the-art methodologies that will fuel our future research teams and companies which will provide the innovation framework the Greece of tomorrow.

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COMMUNICATION

185 Syggrou Ave. & 2 Sardeon St. 2
171 21, N. Smyrni, Greece
+30 210 64 12 410, 420
communication@elidek.gr
www.elidek.gr