IMAAC

Investigation and Mathematical Analysis of Avant-garde

Disease Control via Mosquito Nano-Tech-Repellents

COST Action CA16227

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EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

This publication is based upon work from COST Action IMAAC, supported by COST (European Cooperation in Science and Technology).

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COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks.
Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

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Investigation and Mathematical Analysis of Avant-garde

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Overview

Dangerous mosquito species, such as the Aedes aegyptis species, can carry and spread the diseases Dengue, Zika, Chikunguya and yellow fever. Climate change, urbanization, and global travel are just a sample of the variables increasing the range of vector borne disease transmissions geographically northward out of the tropics. Control of disease transmission has been problematic by being either inefficient (i.e. bed-nets, vaccines) or by having negative environmental impacts to the ecosystem and humans (i.e. insecticide poisoning, chemical runoff).

This COST Action promotes an **interdisciplinary approach** to explore a state-of-the-art method of controlling mosquito activity by the application of nanoparticles for a controlled slow-release of repellents and insecticides: These **"nano-insecticides"** can be applied to textile material and dispersed in paints acting to deter the feeding of mosquitos; protecting humans and livestock from bites.

Further collaboration is needed to evaluate the feasibility and effectiveness of this nanoparticle approach to mosquito control and further the development of a new generation of insecticide applications.

Overall Objective

The overall objective of *COST Action CA16227* is to assess the efficacy of state-of-the-art nano-insecticides imbedded in textiles and paints on mitigating the spread of dangerous vector-borne (mosquito-borne) diseases.

Participation and Networking

This multi-disciplinary COST Action brings together scientists from the fields of ecology, biology, chemistry, mathematics, engineering, and environmental sciences as well as industry partners from agriculture and textile manufacturing.

COST provides the tools to network with partners from across Europe and International Partner Countries to enable innovation in science and technology.

Societal Benefits of IMAAC

- Facilitation of international collaboration between various sciences and industry to develop solutions to vector-borne disease transmission.
- Identification of advanced mosquito-repelling materials
- Reduction of the spread of mosquito-transmitted diseases

Our goal:
reduce mosquito-borne diseases

Our approach:
use nanotechnology to release agents in a well-controlled dosage

Why participate in COST?

COST is an EU-funded programme that enables researchers to establish interdisciplinary research networks in Europe and throughout the world.

Participation in a COST Action provides scientists from diverse fields and sectors the resources to make connections and to collaborate in the development of breakthrough ideas and innovations while enhancing career prospects.

The funds designated allow for experts from different disciplines and at any career stage to network with the goal of increasing communication and developing relationships that go beyond this one Action; creating opportunities for future cooperative research endeavors and state-of-the-art product development.

Funds are used toward activities such as:

- Meetings and workshops
- Organizing conferences
- Training schools
- Short term scientific missions
- Information dissemination activities

Who can join?

COST Actions welcome participation from those working in Universities, research centers, Small and Medium-sized Enterprises (SMEs), and public and private organizations from the 36 COST Member states across Europe and its Cooperating State.

Researchers from Near Neighbour Countries and International Partner Countries can also participate.

Founding Countries

Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Finland, France, Germany, Greece, Iceland, Italy, FYR Macedonia, The Netherlands, Poland, Portugal, Romania, Serbia, Spain, United Kingdom

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Working Group 1:
Data analysis and Statistics

This working group was responsible for modeling and including control measures and invasion scenarios into new world regions like Europe.

Some highlights:

- Cross between applied mathematics, statistical, and epidemiology concerning spreading of mosquito-transmitted infectious diseases on large geographical areas including the complexity and stochastic effects in disease dynamics;

- Define tools to measure the efficacy gained fromthe real data related to disease cases, in case of discussed application of avant-garde mosquito repellents combating diseases using nanomicro-particles on textiles, paints, and other materials.

Working Group 2:
Structured population models and optimal control

This working group focused on the creation of new mathematical models for the transmission dynamics of mosquito-borne diseases. Different mathematical tools were used and combined to better describe the reality and improve the mathematical modeling of infectious diseases.

Some highlights:

- Creation of new mathematical models using different techniques, giving a fit analysis to real data related to mosquito-borne diseases.

- Interaction with multidisciplinary teams and translate the mathematical models and optimal control strategies to concrete and comprehensible public health solutions for the use of mosquito repellents and insecticides.

Working Group 3:
Biological and epidemiological research on vector borne diseases

The working group investigated the effect of described avant-garde mosquito control measures, bringing scientific knowledge from laboratories and field studies together.

Some highlights:

- Investigation of controls using nano and micro technology.

- Study of the combination between control measures with imperfect vaccines due to the recent advances to the production of vaccines.

Working Group 4:
Control Measures with Textiles and Paint

This working group consists of scientists from academia and industry, experts from the disciplines chemistry, physics, surface and material science, textile engineering, biochemistry etc. who jointly contribute and combine their experimental and theoretical expertise here and thus contribute to the group's progress and success.

Some highlights:

- Nanomaterial based solutions and existing agents for the application of synergistic formulations were produced to examine their potential as effective mosquito control repellents.

- Some examples are the textile impregnation with special nanomaterials, nano-based encapsulations for potential agent carriers and the material functionalization for better adhesion properties to attach repellent compounds.

- In laboratory mosquito tests revealed good to very good efficacies. The next steps are the verification of the best combinations in field experiments and the examination of the textile performance and durability of the repellent activity.

Working Group 5:
Pilot field studies and their management

This group was foccusing in the study of the species composition and presence, biting activity of different mosquito species; evaluation on the human biting rates, as well as to determine the best testing time of each mosquito species according their biting activity and gonotrophic cycles.

Some highlights:

- Three study sites were selected and tested in Albania areas: Lushnje: Divjaka Beach and Resort, coastal area, Durres urban coastal area: and Fier: Darzeze Beach and Resort, coastal area.

- Research trial on the repellency efficacy of repellent treated textiles with Aedes aegypti in Cape Verde.

- The study of new strategies on mosquito control and keeping their biting behavior suppressed, brought the need of drawing new techniques like the use of natural repellents, impregnated in different textiles.

Working Group 6:
Data collection, communication and dissemination

This network is highly interdisciplinary, ranging from theoretical modellers to practitioners pursuing field studies. Computer technology was used to support this communication on various levels, namely:

- Mobile devices used to collect data in the field studies
- Data bases provide collected data for further analysis
- Interactive simulators to understand properties of the derived models
- Visualisation techniques to communicate results to scientific journals and to the public

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