Can crab shells provide a 'green' solution to malaria?

May 11 2017

A non-toxic mixture of chitin-rich crab shell powder and nanosized silver particles could be an environmentally friendly way of curbing the spread of disease-carrying mosquitoes, and malaria in particular. This is according to a series of experiments led by Jiang-Shiou Hwang of the National Taiwan Ocean University. The findings are published in Springer's journal *Hydrobiologia*.

Mosquitoes carry diseases such as malaria, dengue fever, yellow fever, the Zika virus and encephalitis. Despite more than 100 years of research on the subject, malaria remains a global health problem, especially in Sub-Saharan Africa and Asia. In 2013, the number of malaria cases was estimated at 198 million, and the number of malaria-related deaths at 548 000. According to the World Health Organization, one child dies every minute from malaria in Africa. Products such as organophosphates, insect growth regulators, microbial control agents and organic solutions are used in efforts to control mosquito populations and the spread of the disease.

Hwang's team turned their attention to chitosan or chitin, a non-toxic natural substance that has been used in wound healing, as drug carriers and in manufacturing membrane water filters and biodegradable food package coating. Chitin is found in animal tissues, such as the exoskeletons of arthropods, bird beaks and insect eggs. It can easily be chemically changed, is quite strong and, because of its abundance in nature, is cost-effective to use.

The research team first crushed and oven-dried the exoskeletons of a number of hydrothermal vent crabs (Xenograpsus testudinatus) before extracting the chitin and other minerals. The subsequent creamy-white filtrate was then mixed with silver nitrate (AgNO3) to obtain a brown-yellow solution of silver nanoparticles (AgNP).

The solution was sprayed over six water reservoirs at the National Institute of Communicable Disease Centre in Coimbatore in India. Even in small concentrates it killed mosquito larvae and pupa quite effectively. It had the greatest effect during the early stages of the mosquito larvae's development.

The solution was also tested in conjunction with freshwater goldfish (*Carassiu auratus*) that fed on mosquito larvae. The nanoparticle solution did not have any effect on the fish, indicating that it is an environmentally friendly and non-toxic product. It also inhibited the growth of disease-causing bacterial species such as Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae and Proteus vulgaris.

"This research highlighted that chitosan-fabricated silver nanoparticles are easy to produce, stable over time, and can be employed at low dosages to strongly reduce populations of the malaria vector, the *Anopheles sundaicus* mosquito, without detrimental effects on the predation of natural mosquito enemies, such as goldfishes," says Hwang. "It also effectively inhibits important bacterial pathogens."

Hwang hypothesizes that the nanosized particles pass through the insect cuticles and into individual cells to then interfere with various physiological processes that are part of a mosquito's life cycle.

More information: Kadarkarai Murugan et al, Chitosan-fabricated Ag nanoparticles and larvivorous fishes: a novel route to control the coastal malaria vector Anopheles sundaicus?, *Hydrobiologia* (2017). DOI:

10.1007/s10750-017-3196-1

Provided by Springer