Researchers find gene-silencing nanoparticles may put end to pesky summer pest

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Summer just wouldn't be complete without mosquitoes nipping at exposed skin. Or would it? Research conducted by a Kansas State University team may help solve a problem that scientists and pest controllers have been itching to for years.

Kun Yan Zhu, professor of entomology, and teammates Xin Zhang, graduate student in entomology from China, and Jianzhen Zhang, a visiting scientist from Shanxi University, China, investigated using nanoparticles to deliver double-stranded ribonucleic acid, dsRNA -- a molecule capable of specifically triggering gene silencing -- into mosquito larvae through their food. By silencing particular genes, Zhu said the dsRNA may kill the developing mosquitoes or make them more susceptible to pesticides.

Gene silencing triggered by dsRNA or small interfering RNA, siRNA, is known as RNA interference, or RNAi.

"RNAi is a specific and effective approach for loss of function studies in virtually all eukaryotic organisms," Zhu said. Eukaryotic organisms have cells that contain a nucleus within which genetic material is carried and can therefore be manipulated. Almost all animals, plants and fungi are eukaryotes.

Once RNAi is triggered, it destroys the messenger RNA, or mRNA, of a particular gene. This prevents the translation of the gene into its product, silencing it. In the case of Zhu's research, RNAi was used to silence

genes responsible for the production of chitin, the principle constituent of the exoskeleton in insects, crustaceans and arachnids.

"Since our RNAi is focused on chitin synthesis, the dsRNA that is delivered into the mosquito larvae can basically block the production of chitin," Zhu said.

Though the silencing is not yet 100 percent effective in their study, Zhu said it does leave the mosquito's body with less ability to combat insecticides, which must penetrate the mosquito's exoskeleton. If the gene, called chitin synthase, could be completely silenced, the mosquitoes may die without the use of pesticides because the chitin biosynthesis pathway would be blocked, Zhu said.

Zhu theorized using nanoparticles to deliver dsRNA to mosquito larvae might work because of the low success of manually injecting larvae with dsRNA. Mosquito larvae live in water but because dsRNA quickly dissipates in water, it can't be directly added to the larvae's food source. Zhu's group discovered that using nanoparticles assembled from dsRNA facilitates their ingestion by mosquito larvae because the nanoparticles don't dissolve in water. Zhu said the nanoparticles may also stabilize the dsRNA in water.

"Now insects will have a much greater likelihood of getting these nanoparticles containing the dsRNA into their gut through feeding," Zhu said.

Potentially, bait containing dsRNA-based nanoparticles could be developed for insect control, Zhu said.

"Because we can select specific genes for silencing, and the nanoparticles are formed from chitosan -- a virtually non-toxic and biodegradable polymer -- this pest control technology could target

specific pest species while being environmentally friendly," he said.

Mosquitoes were chosen, Zhu said, because of the abundant research on them as human disease vectors. Other insects, though, can have their genes silenced. Zhu and his collaborators also have investigated gene silencing in the European corn borer and in grasshoppers, a major insect pest in China. Nanoparticles did not have to be used because grasshoppers and European corn borers are not aquatic. However, nanoparticle-based RNAi may facilitate the studies on the functions of new genes.

More information: The team's paper, "Chitosan/double-stranded RNA nanoparticle-mediated RNA interference to silence chitin synthase genes through larval feeding in African malaria mosquito (Anopheles gambiae)," was recently accepted by the journal, *Insect Molecular Biology*. It has been published online in advance of print.

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