Use of cDNA Microarray to Isolate Differentially Expressed Genes in White Spot Virus of Infected Shrimp

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Background

White spot syndrome is a highly contagious viral disease that has nearly wiped out commercial shrimp farming in Asia. The disease, caused by the white spot syndrome virus, is currently the most costly viral pathogen infecting farmed shrimp worldwide. It infects penaeid shrimp, a family of prawns that includes many commercially farmed and wild species.

The first reported epidemic of white spot syndrome was in 1992 in Taiwan, and it has since spread to North America. Today, Australia is the world's only shrimp-growing region that does not contend with the disease.

Shrimp farms, most of which are in Asia, supply more than a quarter of the total shrimp consumed globally. In 2003, about 1.6 million tonnes of farmed shrimp were produced, worth about $9 billion (USD). The United States and Japan are the world's largest importers of farmed shrimp.

Viral diseases are often elusive to cure and the white spot syndrome is proving to be no exception. At present, there are no treatments for the disease, but disinfectants are used to help prevent outbreaks at shrimp farms where crowded rearing conditions are conducive to epidemics.

A true cure for the disease would be a huge boon for the growing global shrimp industry and for American consumers for whom shrimp continues to be a favorite seafood product.

Project

In this Sea Grant project, researchers led by Arun Dhar of San Diego State University studied the molecular underpinnings of white spot disease and identified genes involved in the immune response to the white spot syndrome virus.

Dhar and colleagues employed a technology known as microarray analysis to examine the genes expressed in the hemocytes and hepatopancreas tissues of healthy and infected wild shrimp. Gene expression is the process by which a gene's DNA sequence is converted into RNA, which, in turn, codes for the production of proteins that regulate a cell's functions. Knowing which genes the white spot virus activates is thus a road map of the biological pathways critical for development of the disease. It opens the door to finding cures for the disease and/or to identifying disease-resistant strains of shrimp that might be bred for aquaculture.

The hepatopancreas is a digestive organ in crustaceans that performs functions similar to those of the liver and pancreas in humans. The emphasis on tracking gene expression in hepatopancreas tissues reflects the fact that the disease causes white spots on these tissues.

In simple terms, the two main objectives of this project were to: (1) Compare gene expression profiles in hemocytes of healthy and infected wild *Penaeus stylirostris* caught in the Gulf of California; and (2) Isolate and characterize those genes that are expressed differently in healthy and infected shrimp.

Results

Researchers showed that infection alters the expression of a wide array of genes, including those that are involved in crustacean immune function, signal transduction, structural genes and mitochondrial genes.

They also identified a candidate receptor gene for another important viral shrimp pathogen, the Taura syndrome virus. This work has illustrated the potential to use the mRNA expression level of candidate genes as biomarkers for identifying virus-resistant or virus-susceptible lines in shrimp.

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It also advances efforts to identify "targets" for developing therapeutics for white spot disease.

"This research is exciting because it deals with a cutting-edge technology used by pharmaceutical companies and research institutions working on drug discovery for human diseases," Dhar said. "We've used this technology to deal with a major problem in shrimp aquaculture."

Publications

Dhar, A. K., Dettori, A., Roux, M. M., Klimpel, K. R., and Read, B., 2003. Identification of differentially expressed genes in white spot syndrome virus infected shrimp (*Penaeus stylirostris*) by cDNA microarrays. Arch. Virol. 148, 2381-2396.

Presentations

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