Scientist spotlight

Agrigenomics: Opportunity Biotech uses microarray technology to improve tilapia breeding and address the challenges to global food security

Millions of people around the world rely on farmed fish for food and nutrition. Of all the fish species, carp is the most cultivated, followed closely by tilapia, with production of around 6 million tons each year and a market size that is expected to reach $11.3 billion USD by 2032 [1].

But today's tilapia farmers are facing serious challenges.

Years of inbreeding has reduced viability and fertility, leading to dramatic losses in tilapia productivity. These issues are compounded by the rising risk of bacterial infection, a problem fueled by warming water temperatures due to climate change.

What can be done to overcome these challenges, accelerate breeding programs, and enhance tilapia aquaculture? Can lessons learned from tilapia fisheries be used to improve the management of other economic species and global food security overall?

Arthur Z. Wang is the Chief Technical Officer of Opportunity Biotech Co., Ltd. He holds a PhD in Agronomy from National Chung-Hsing University, awarded in 2013. His areas of expertise include genetics, breeding, genomic breeding, molecular biotechnology, bioinformatics, and systems biology.

Opportunity Biotech is pioneering agricultural genomics and the precision breeding of economic species such as tilapia

Opportunity Biotech Co., Ltd (OPPTY) is a biotechnology company that specializes in developing innovative solutions for agricultural genomics and precision breeding. Headquartered in New Taipei City, Taiwan, the company focuses on the production, management, and application of genomic data for genotype management, performance testing, germ plasm propagation, genetic and breeding consultation, and the development of livestock and fishery electrogenesis.

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As Wang explains, the problems facing today's fisheries cannot be resolved through traditional farming techniques. Instead, more and more aquaculture farmers are turning to advanced genomic analysis to refine the breeding process.

"We work with breeders to improve their stocks. We're able to combine what we know from our genetic analysis with the phenotypes a breeder is seeing in the field, and then use that information to help them get to the next stage," Wang says.

Precision breeding relies on Axiom Genotyping Solution from Thermo Fisher Scientific

Opportunity Biotech uses the Applied Biosystems™ Axiom™ Genotyping Solution for genotype biomarker analysis. This powerful tool includes a microarray platform that not only can carry out genome-wide genotypes but can also detect 900,000 single-nucleotide polymorphism (SNP) markers in a single run, making it efficient and cost-effective. Axiom genotyping arrays are synthesized in situ using a proprietary photolithographic technology that is designed to deliver 100% fidelity with no dropped SNPs. That means users can expect the same content every time, between and across manufacturing batches [2].

Initially, Opportunity Biotech built a Taiwan porcine breeding database and performed genome-wide genotyping for 3,600 swine, using an Axiom porcine breeder array and comparing it with other platforms.

"We found that the Axiom Genotyping Solution is competitive in terms of data quality and cost," Wang explains. "This solution, coupled with the [Applied Biosystems™] GeneTitan™ Multi-Channel (MC) Instrument, automates array processing from target hybridization to data generation, and can rapidly produce data within a week. This enables us to provide large-scale genotyping data at an affordable price."

The Axiom Genotyping Solution can be customizable for high-throughput applications, so all markers of interest can be targeted and manufactured on the custom array. For Wang, this customizability is a key component to their success with precision breeding programs.

"Because we are able to build new, customized arrays, we can help more customers, and we can do it in a way that is in balance with their funding," he says.

The role of artificial intelligence (AI)

Conventional whole-genome analysis, including genetic analysis and interpretation, is case-by-case and based on different farms and breeds—which makes breeding processes time-consuming and labor-intensive. Now, Opportunity Biotech is using AI to help tilapia farmers breed faster and with more data-driven information than ever before.

"By leveraging big data repositories and AI, decision-making (or prediction) systems can be developed that not only speed up genetic analysis and interpretation but also enable comprehensive farm decision-making," Wang says.

Helping tilapia farmers in Taiwan

Opportunity Biotech is the first to offer these advanced breeding techniques to tilapia farmers in Taiwan, where tilapia is one of the main fish species bred. Each year, aquaculturists in Taiwan produce about 70,000 tons of tilapia; but now, challenges related to inbreeding and warming water temperatures are threatening Taiwan's fragile tilapia stocks. According to Wang, traditional farming strategies cannot overcome these hurdles.

"In this moment, farmed tilapia has a less than 50% survival rate," he explains. "And farmers can't tell from the phenotype alone what the problem is. If they look at the fish, each one is very similar. A farmer can't distinguish one from another."

To break through existing breeding restrictions and accelerate breeding programs, Opportunity Biotech developed Taiwan's first Applied Biosystems™ Axiom™ Aquatic Array, to decode the whole-genome sequence of tilapia. This database is now being used for the identification of molecular markers for disease resistance and other desirable quantitative traits.

"We use genetic analysis to clarify the genetic relatedness of fish stocks and proceed with pedigree planning according to the test results. Our goal is to maintain genetic diversity of fish, thereby reducing the probability of inbreeding," Wang says. "We are also working toward the development of genetically improved tilapia strains, promoting faster growth and disease resistance."

Next-generation breeding to improve food security worldwide

Tilapia farmers aren't the only ones eager for their stocks to have antiadversity characteristics such as disease resistance, early maturity, high yield, and heat tolerance. Opportunity Biotech is also moving ahead with similar aquaculture projects aimed at grouper, shrimp, and crabs—all threatened by climate change and traditional farming practices.

In each case, the application of whole-genome analysis and breeding can be divided into three phases: basic genetic analysis, advanced genetic analysis (loci mapping), and genomic breeding.

"Generally, whole-genomic analysis on farms is only used to identify varieties/breeds and purity, though on a few farms it is also used for breeding management. Only academics and breeding companies are searching for linkage/associated molecular markers to assist breeding," Wang concludes. "With the help of big data, whole-genomic analysis can effectively predict performance, thus accelerating breeding progress and reducing breeding scale, and helping farms and breeding companies select great breeds with stress resistance and good health."

As Opportunity Biotech has shown, the Axiom Genotyping Solution for agrigenomics can help breeders and researchers identify, validate, and screen complex genetic traits in animals. It is hoped that this information can be used to improve food production, address climate change challenges, and enhance sustainability in agriculture.

Resources:

1. **www.imarcgroup.com/tilapia-market**. Accessed 18 Sept. 2024.
2. **https://www.thermofisher.com/us/en/home/life-science/microarray-analysis/agrigenomics-solutions-microarrays-gbs/axiom-genotyping-solution-agrigenomics.html**. Accessed 18 Sept. 2024.

Learn more at **thermofisher.com/microarrayagrigenomics**

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