Scientist spotlight

GenoMar Genetics Group: Transforming tilapia farming with microarray technology

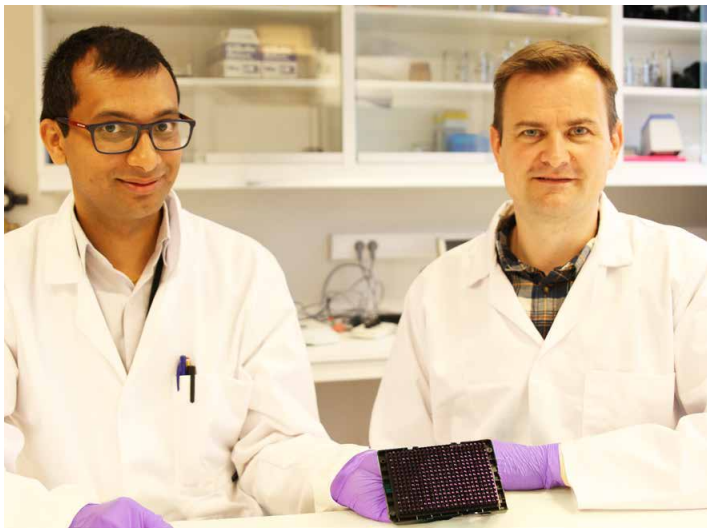
Tilapia: A major global commodity

As the world's population grows, tilapia plays an increasingly important role in tackling challenges of global food security and sustainability. These fish are a nutritious and affordable source of protein, and they can be farmed sustainably with minimal impact to the environment [1]. Tilapia is an ideal species for farming (especially in developing countries where there may be fewer resources for fisheries) due to their rapid growth rate, high feed conversion efficiency, and high reproduction in captivity. Tilapia farming requires less investment in infrastructure and management compared to farming other species of fish.

Tilapia aquaculture has grown significantly since the late 1980s, following the development of the Genetically Improved Farmed Tilapia (GIFT) strain by Norwegian and Philippine researchers [2]. Today, tilapia is one of the most widely farmed fish in the world, second only to carp [3]. It can thrive in diverse environments, such as a wide range of water temperatures, salinities, and other environmental conditions. The reason for the increase in tilapia farming is two-fold: there are more opportunities for aquaculture, and innovative technologies have been able to improve farming outputs. Selective breeding with genotyping solutions, such as microarray technology, has helped to increase productivity in tilapia farming.

GenoMar Genetics Group: Pioneers in incorporating innovative technologies for selective breeding

GenoMar Genetics Group, a subsidiary of EW Group, is an international aquaculture breeding and distribution company providing genetically improved tilapia to farmers around the world [4]. Founded with the goal of using selective breeding to enhance important traits, such as growth, survival, disease resistance, and feed efficiency, GenoMar has been a leader in incorporating genotyping solutions for genetic improvement in tilapia for decades. The company's motto, "Always one generation ahead," reflects its commitment to continuous innovation and progress in aquaculture breeding.



Dr. Rajesh Joshi and Dr. Anders Skaarud serve as senior researchers in the central research and development (R&D) department at GenoMar Genetics Group in Oslo, Norway.

With breeding centers in Norway, Asia, and Latin America, the company manages innovative technology programs for some of the most recognized independent brands in the industry, such as GenoMar and Aquabel. Under these brands, they distribute more than 500 million fish to customers annually in the form of tilapia fingerlings and juveniles, which are fish at different sizes that can be used for farming. To further enhance its product range, GenoMar Genetics has developed multiple breeding lines and strategically crossed them to create diverse products, such as GenoMar 250, GenoMar 1000, and GenoMar STRONG [5]. These offerings cater to different global market needs, optimizing tilapia performance for various farming environments and production goals.

Dr. Rajesh Joshi and Dr. Anders Skaarud serve as senior researchers in the central research and development (R&D) department at GenoMar Genetics Group in Oslo, Norway. Their roles encompass overseeing the planning and execution of various activities within the breeding nucleus and multiplication facilities of tilapia, located in both the Philippines and Brazil. According to Drs. Joshi and Skaarud, using microarray technology for selective breeding—especially for traits like disease resistance, which cannot be directly measured in breeding candidates—has the potential to significantly enhance tilapia performance. GenoMar offers genetically improved fingerlings and juveniles that have been bred for growth and fillet yield potential, resistance to diseases, and high survivability. Commercial field studies have shown that their fingerlings can help farmers increase production and profitability by more than 30% [6].

Developing the first commercially available genotyping tool for tilapia

Using innovative technologies to improve tilapia aquaculture is at the core of GenoMar's business. Through collaboration with Thermo Fisher Scientific, GenoMar developed a single-nucleotide polymorphism (SNP) microarray panel for Nile tilapia and implemented genomic selection in the company's routine selective breeding program in 2016. Since genomic selection was combined with precision breeding, GenoMar tripled the rate of genetic gain for growth in the GenoMar breeding program [6]. Drs. Joshi and Skaarud were responsible for product planning and the coordination of benchmarking, documentation, and performance evaluation efforts in key geographic regions.

The custom, high-density Applied Biosystems™ Axiom™ SNP microarray, named by GenoMar as the Applied Biosystems™ Axiom™ Onil50 array, included 58,000 SNPs from the tilapia genome [6]. However, after using the array for several years and testing nearly 300,000 tilapia fish [6], they found that some of the SNPs did not produce good genotypes, which prompted GenoMar to explore making an updated array.

The updated Axiom SNP array, the Applied Biosystems™ Axiom™ Onil70 array, included 40,000 markers from the original array, plus more than 30,000 new SNPs. Because the GenoMar team had extensive data on the performance of the Axiom Onil50 array, they were able to select genetic markers using both long-read and short-read sequences that would make the most impact. Over time, the team can remove any SNPs that are no longer needed or incorporate others to improve the precision and accuracy of their breeding programs. Using microarrays, GenoMar can identify genetic markers that are ideal for their fingerlings.

Gaining genetic insights to help tilapia farmers overcome common challenges

One of the main issues tilapia farmers face is disease, which poses a significant threat to both large commercial farms and small-scale operations. At GenoMar, the team leverages microarray solutions to improve disease resistance and economically important traits, resulting in robust fingerlings known for resilience and exceptional survival.

For example, their GenoMar STRONG is a genetically selected tilapia strain bred for resistance to Streptococcosis, a widespread bacterial disease that affects Nile tilapia worldwide. This disease has become endemic in many tilapia farms around the world and can cause up to 70% mortality in acute cases, leading to severe economic and social consequences [7]. While farmers can implement certain control measures once an outbreak occurs, having resistance already built into the fingerlings is a more efficient and cost-effective approach. Over time, the GenoMar STRONG brand has evolved and now offers protection against multiple major bacterial diseases affecting tilapia while also maintaining high growth rates and improved fillet yield, delivering farmers a more resilient and productive stock [8].

Another major challenge for tilapia farmers is overcoming low profit margins; however, fingerlings can be bred for improved feed efficiency, growth rate, and overall productivity. Drawing inspiration from the poultry industry—where genotyping solutions have led to the sector's expansion and the development of genetically superior birds over the last few decades—GenoMar applies microarray technology to advance tilapia breeding, with the vision of making the species the "aquatic chicken." While tilapia can thrive in a variety of environments, achieving large-scale commercial production comparable to modern commercial poultry farming requires selective breeding. This breeding focuses on faster growth, higher fillet yield, and improved survival rates that far exceed the current limits. In fact, GenoMar's recent predictions indicate that honing selective breeding and genomic selection for tilapia could yield a 210% genetic gain for its GenoMar 1000 brand [6], a fast-growing tilapia genetically selected for high-yield farming [9].

The benefits of using Axiom microarrays to improve tilapia breeding programs

While aquaculture is one of the fastest-growing food industries, only 10% of aquaculture products are based on genotyped data [10]. Using genetics to guide tilapia breeding has the potential to have a significant, positive impact on farmers, and a sustainable tilapia industry can have resounding effects on society, helping us collectively meet the demands for global food security and lessen negative environmental impact. By leveraging innovative technologies, GenoMar hopes to improve breeding decisions that translate into better products and a more profitable and sustainable tilapia industry.

For genomics to meet the needs of aquaculture breeding programs, technology must deliver accurate data with fast turnaround and at a low cost. The Applied Biosystems™ Axiom™ Genotyping Solution for agrigenomics offers catalog and customizable content to genotype any species, genome size, or ploidy level with high fidelity, robustness, and reliability. Thermo Fisher is committed to developing solutions and supporting expertly designed arrays for specific aquaculture species to accelerate genomic discovery and breeding programs.

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