Health & Welfare

Quality, survival of L. vannamei offspring from ablated, non-ablated females

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Progeny from non-ablated females more robust when challenged with Acute Hepatopancreatic Necrosis Disease and White Spot Disease

Evaluating the quality and survival of Pacific white shrimp postlarvae from non-ablated female broodstock, a holistic biosecurity and management strategy. Photo by Simão Zacarias.

The global shrimp farming industry is affected by regular episodes of diseases like Acute Hepatopancreatic Necrosis Disease (AHPND) – commonly referred to as Early Mortality Syndrome (EMS) – and White Spot Disease (WSD). These episodes can result in catastrophic crop failures with consequential severe financial losses. Finding ways to reduce the impact of diseases and ensure high rates of survival has long been a key industry objective.

Eyestalk ablation of shrimp female broodstock remains a standard practice in most hatcheries worldwide but it has been increasingly criticized for its impact on welfare, broodstock condition (nutritional and/or physiological status) and on the quality of offspring produced (e.g. postlarvae, or PLs).

The resistance or tolerance of shrimp seedstock to disease challenges in farms, in part, depends on broodstock quality and genetics. Theoretically, non-ablated females should demonstrate better overall condition than ablated animals as the latter have higher exposure to physical trauma, stress, physiological imbalance and activation/reduction of immune related genes as a consequence of ablation.

The health of broodstock may consequentially be reflected on the quality of their offspring. Producing Pacific white shrimp (*Litopenaeus vannamei*) postlarvae and juveniles from high welfare, non-ablated females in commercial hatcheries could result in significant increases in the survival of animals, particularly during periods when they are under stress (e.g. during the early phase of pond culture) or, more critically, when faced with exposure to pathogens like *Vibrio parahaemolyticus,* causing AHPND and/or White Spot Syndrome Virus (WSSV), causing WSD.

Editor's note: Dr. Zacarias' research won the 2020 Global Aquaculture Innovation Award: (https://www.aquaculturealliance.org/blog/2020-aquaculture-innovation-award-winner/?__hstc=236403678.01a793fa263e54d732727684a48ace38.1680742356646.1680742356646.1680742356646.1&__hssc=236403678.1.1680742356647&__hs

"Innovation Award 2020 finalist: Simao Zacarias' shrimp eyestalk ablation research (https://www.aquaculturealliance.org/advocate/innovation-award-2020-finalist-simao-zacarias-shrimp-eyestalk-ablation-research/?__hstc=236403678.01a793fa263e54d732727684a48ace38.1680742356646.1680742356646.1680742356646.1&__hssc=236403678.1.1680742356647&__h

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Study setup

We conducted research trials in Thailand to explore this study hypothesis using *L. vannamei* postlarvae originating from a single population of female broodstock from SyAqua Siam, half of which were ablated and half non-ablated. The postlarvae (PLs) produced were subsequently transferred to Benchmark's R&D (Thailand) for testing.

For the AHPND challenge tests, groups of 100 PLs (average weight 14 mg) from either ablated or non-ablated females were placed in 20-liter tanks. Five replicates were stocked per condition (ablated or non-ablated) and water maintained at 15 ppt and 29.05 ± 0.13 degrees-C. The PLs were exposed to 2.0×10^8 CFU/ml of a pathogenic isolate of *Vibrio parahaemolyticus* (Vp_{AHPND}) and then checked every three hours over the subsequent 96 hours.

The WSD challenges tests were carried out with juveniles (average weight 1.42 ± 0.07 grams) held individually in 1-liter vessels (50 replicates per condition). Salinity and temperature were maintained at 15 ppt and 26.33 ± 0.73 degrees-C, respectively. Oral challenges were done by feeding a 0.1-gram ration of WSSV-infected *L. vannamei* tissue (average 2.02×10^9 WSSV per ration) and the shrimp monitored every three hours over the subsequent 162 hours. For full details relating to the experimental challenges, refer to Zacarias, S. et al. (2020) *Aquaculture*, 552: 736033 (https://doi.org/10.1016/j.aquaculture.2020.736033 (https://doi.org/10.1016/j.aquaculture.2020.736033)).

Results and discussion

The AHPND challenge showed that PLs from ablated females had significantly (p = <1.3E-36) lower survival (38.8 percent) than those from non-ablated females (70.4 percent) (Fig. 1). Juveniles originating from non-ablated animals also had higher, but not significantly so (p>0.05) survival (62 percent) than those from ablated females (48 percent) when challenged with WSD (Fig. 2).

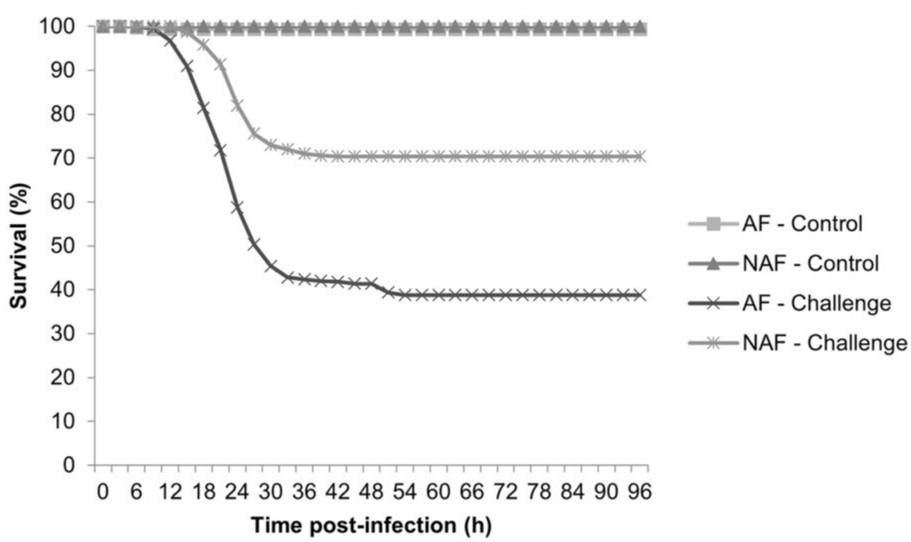

Fig. 1: Survival of non-challenged and Vibrio parahaemolyticus-challenged *L. vannamei* PL17 originating from non-ablated female (NAF) and ablated female (AF) broodstock.

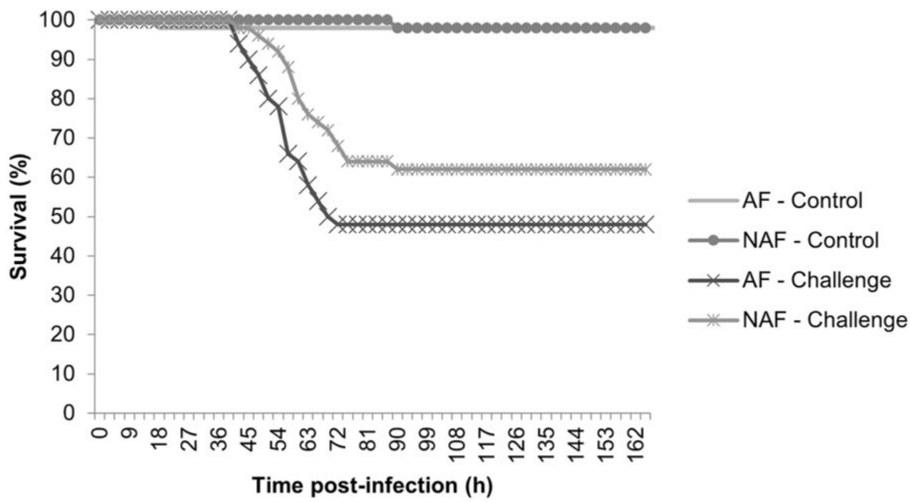

Fig. 2: Survival of non-challenged and WSSV-challenged juvenile *L. vannamei* originating from non-ablated female (NAF) and ablated female (AF) broodstock.

The results clearly suggest that the negative impacts of ablation could be carried over and affect the health or fitness of the offspring. Negative impacts of maternal health and nutrition on their offspring have been reported previously in fish. These results suggest that the stresses associated with ablation have a similar effect on shrimp, although the underlying mechanisms are not yet understood.

The industry has used unilateral eyestalk ablation for decades to ensure a steady supply of nauplii for the hatchery and nursery phases of production. It is widely believed that ablation increases the frequency, productivity and consistency of nauplii production. The practice of ablation, however, has come under increasing scrutiny by retailers and consumers, threatening market access.

Results of this study show that ablation can also carry hidden negative costs through reduced ability of PLs and juveniles to survive disease challenges. These costs (and losses) may not be evident until the PLs are stocked in farms. Hatcheries operating without ablation may have to stock additional females to compensate, although previous tests showed that nauplii production rates could be maintained through improved management and feeding regimes.

Our innovative research addressed key welfare concerns of unilateral eyestalk ablation, antibiotic and chemical usage in shrimp production, and the management and control of shrimp diseases. Offspring from non-ablated female are more resistant to commonly encountered diseases, meaning higher rates of stock survival and reduced demand for expensive (and often ineffective) treatments. This approach reduces the probability of financial losses, contributing to the sustainability of the industry and, critically for small scale farmers, ensuring shrimp farming is a viable livelihood option.

Perspectives

The breakthrough findings in our study can be expected to become a key health strategy in shrimp farming going forward. Shrimp hatcheries switching to a non-ablation-based system would produce robust animals which may command a higher price based on quality and welfare.

In the future, farmers could insist on animals from non-ablated broodstock as part of a holistic biosecurity and management strategy, thus improving productivity during disease outbreaks without resorting to more costly and less effective treatments.

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