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Biosecurity principles for sustainable production using SPF shrimp

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Monitoring programs mitigate spread of infection



Biosecurity is essential to realize the full genetic potential of selectively bred SPF stocks, such as this broodstock shrimp from Oceanic Institute.

Over the past decade, trends in the global shrimp-farming industry include the use of specific pathogen-free (SPF) shrimp to mitigate crop loss from viral pathogens, which historically have caused significant declines in production and profitability for shrimp farmers worldwide. This is especially true for SPF stocks of Pacific white shrimp (*Litopenaeus vannamei*), which since their introduction to Asia in the late 1990s have resulted in a dramatic increase of global shrimp production over the past several years.

The establishment of SPF shrimp and concomitant development of domestication and breeding programs has been an important step in the development of a mature, sustainable shrimp-farming industry.

SPF and biosecurity

An essential component of the SPF concept is biosecurity, the understanding and enforcement of which is critical to realize the full genetic potential of selectively bred SPF shrimp stocks. As it applies to aquaculture, biosecurity can be defined as the practice of exclusion of specific pathogens from cultured aquatic stocks in broodstock facilities, hatcheries and farms, or from entire regions and countries for the purpose of disease prevention.

In the context of shrimp farming, some of the basic components of biosecurity include knowledge of the diseases of concern and excludable diseases/pathogens, adequate diagnostic/detection methods and the use of healthy “clean” shrimp stocks. Environmental controls prevent the introduction and spread of pathogens, while effective culture and management practices support their continuous implementation. Monitoring programs can mitigate the spread of infection, and disease containment, eradication and disinfection plans should be in place in the event of a disease outbreak.

Health management

The pathogens that can lead to disease outbreaks include viruses, bacteria, fungi, parasites and commensals. Toxic syndromes and environmental extremes also may compromise shrimp health and lead to secondary pathogen infection.

Important health management considerations used to preclude pathogenic infection include stock control, feeding, water quality, aeration, and proper sanitation and disinfection procedures. Of these, stock control is the most important, as it serves as the basis of the SPF concept, although environmental controls to exclude pathogens are also essential to maintain stock health.

The underlying principles of pathogen exclusion are primarily focused on pathogens that may be accurately identified using current diagnostic methods. Molecular biology techniques such as polymerase chain reaction testing aimed at identifying specific pathogens, as well as direct microscopy aimed at identifying more general symptoms of disease are commonly used in this regard.

Opportunistic, non-excludable pathogens such as *Vibrio* species can cause infection due to poor husbandry practices or environmental extremes. Further, some disease agents may be non-excludable because current diagnostic methods are inadequate for their detection, or exclusion methods are cost-prohibitive.

Although the most common pathogenic vectors for shrimp disease are waterborne or airborne, diseases can also be brought into culture environments through infected shrimp seed, infected feed, human traffic and other fomites such as non-sanitized nets and equipment. There are also varying degrees of risk associated with different disease vectors, ranging from the high risk regarding movement of live shrimp from infected areas to the low risk of processed feeds with shrimp meal (Fig. 1). Site-specific risks and management considerations dictate biosecurity strategies in regard to pathogen exclusion.

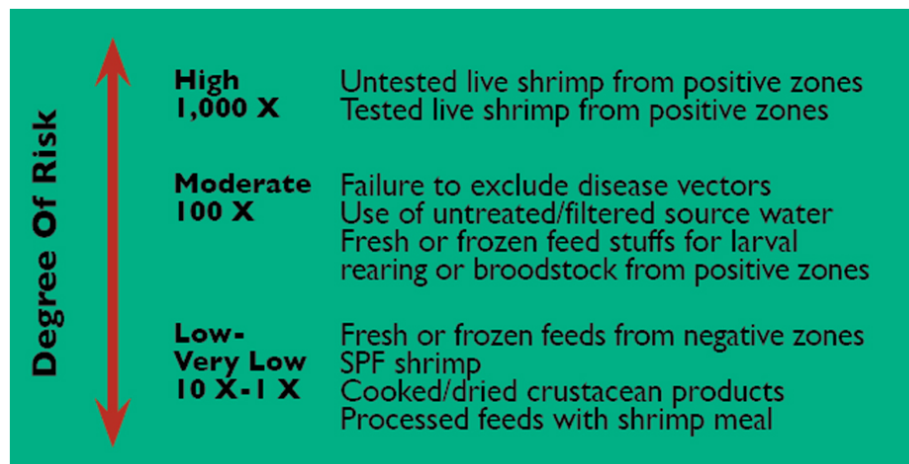


Fig. 1: The relative levels of risk presented by certain types of shrimp products. From "Biosecurity in Aquaculture Production Systems; Exclusion of Pathogens and Other Undesirables," by Donald V. Lightner, 2003.

Disease control

In order to implement an effective facility-wide biosecurity plan, there are several disease control measures to consider throughout all phases of production. These include the proper filtration and disinfection of source water and effluent. The verification and dedicated use of pathogen-free stocks and feed sources, coupled with the use of bio-secure production systems, are also important measures in reducing the potential of disease introduction.

From an operational standpoint, restricting public access and the movement of animals, personnel and equipment within a facility helps to mitigate the occurrence and spread of disease. Importantly, the implementation of a disease-monitoring program may preempt the spread of infection. Disease surveillance programs are especially important in documenting health status over time and maintaining stock control.

Maturation, hatchery operations

For maturation and hatchery operations, the identification of critical control points and optimal workflow patterns aimed at minimizing risk of infection are important considerations for an effective biosecurity plan. Key areas of focus include controls at facility entrances to prevent transfer of infection from the environment at large and implementation of appropriate water treatment methods to exclude pathogens and ensure a healthy rearing environment.

Other key areas are the verification and/or screening of incoming broodstock into maturation systems to ensure SPF status and the use of feeds screened for shrimp pathogens, disinfected or coming from known SPF sources. Hatchery disinfection of eggs and nauplii, and routine cleaning and disinfection of equipment and supplies (including air and water lines) are important points, as well as quality control and disinfection of live feeds, including algae and artemia.

Bacteria and fungi are the major pathogens of concern in maturation/hatchery operations. Regular dry-out periods have proven effective in mitigating these types of disease outbreaks. Dry-out periods can be supported by the “all in, all out” strategy practiced by many commercial hatchery operators to disinfect production facilities between runs.

To succeed, these 660-m² covered and lined shrimp ponds in China must closely control the culture environment by applying biosecurity in every aspect of operation.

Grow-out operations

For grow-out operations, shrimp farm design can influence the effectiveness of a biosecurity plan. Site location relative to other farms, canal design in regard to source water and effluents, compartmentalization of ponds, and type of culture system used (outdoor, enclosed, minimal water exchange, recirculating, etc.) all play important roles in determining how proper biosecurity plans are structured and implemented. Management strategies for effective biosecurity include seawater filtration/disinfection procedures, the implementation of postlarvae quality-assurance programs and stocking of larger postlarvae or juveniles to improve early survival and shorten the production period.

Managers must be aware of on-farm disease “triggers:” abrupt changes in water quality; extremes in salinity, temperature and pH; low dissolved-oxygen levels; high densities; concentrations of toxic compounds in the water; high levels of suspended solids; unstable phytoplankton blooms; chronic shortages of food; excessive handling; and background diseases in the environment.

Various pond management strategies can be employed to control such triggers and mitigate disease outbreaks. These strategies range from minimal water usage to culture ponds being fallowed and treated between crops. Certainly, in order to design an effective biosecurity plan, basic knowledge of the epizootiology of a particular disease must be known in order to understand how pathogens may be transmitted and how to prevent infection.

Currently, major pathogens of concern in grow-out pond environments include white spot syndrome virus (WSSV), yellow head virus, Taura syndrome virus (TSV) and infectious myonecrosis virus. These viral pathogens all have unique modes of infection and can be transmitted via various vectors.

Certain vectors can be mitigated by appropriate filtration, pond coverings and regulation of temperature and salinity. For example, the filtration of source water down to 250 μ to prevent the introduction of carriers, as well as maintaining rearing temperatures above 32 degrees C to minimize infection has proven effective as a strategy against WSSV. Similarly, infection by TSV, which has an airborne vector via bird feces, can be mitigated by pond covers – which can also serve a dual purpose as thermal insulators.

Perspectives

In summary, a keen appreciation of the relationships among stock health, the environment and mechanisms of infection that can cause disease outbreaks is central to the effectiveness of any biosecurity effort. In actual practice, biosecurity involves the identification of risks and the continuous implementation of measures to reduce those risks. Ultimately, economic considerations also play a crucial role in determining the scope of an effective biosecurity plan.

Importantly, the development of standard operating procedures that outline control protocols and well-trained staff who understand the nature of infectious agents and how they are transmitted by human and other vectors are essential aspects of biosecurity that serve to promote the continued development of a mature, sustainable shrimp-farming industry worldwide.

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