Probiotic wafers in aquaculture: Innovative application in shrimp farming

A technical examination of wafer-based probiotic delivery systems and their impact on commercial aquaculture operations

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Modern aquaculture faces complex challenges which include production efficiency, animal health management, environmental sustainability, and biosecurity concerns. Traditional powdered probiotics, while offering proven benefits, have practical limitations. They often present difficulties in preparation and application consistency, with dosage constraints that limit their effectiveness in commercial settings.

Recent developments in probiotic delivery systems include the introduction of wafer-based formulations that address many of these operational challenges, widening the applicable dosage ranges while potentially improving biological outcomes. Leading this innovation is INVE's Sanolife™ PRO-TAB wafers, a unique departure from conventional approaches that offers producers an entirely new paradigm for maintaining healthy production systems while simplifying daily management protocols.

Technical innovation in probiotic delivery

Physical characteristics and design

The latest generation of probiotic wafers represents a fundamental shift in how beneficial bacteria are delivered to aquaculture species. As traditional powder formulations, these wafers contain multiple carefully selected bacterial strains, typically including *Bacillus subtilis*, *B. pumilus*, and *B. licheniformis*, encapsulated within a water-stable matrix designed for optimal performance in aquatic environments.

The wafers are engineered as thin discs, typically 1-2 mm thick, manufactured in two standard sizes: 2 mm and 5 mm diameter to accommodate different production stages and species sizes. A critical design feature is that, unlike shrimp feed pellets, the wafers are intentionally slow-sinking.

Bacterial composition and concentration

The technical specifications demonstrate sophisticated design approaches compared to probiotics top-coated on feed pellets. Each gram contains much higher concentrations of viable bacteria, typically exceeding 2 billion colony-forming units per gram (CFU/g), ensuring adequate bacterial populations for effective colonisation after ingestion.

Attractant coating and feeding stimulation

The wafers incorporate a specialised attractant coating that serves a dual purpose - enhancing palatability to stimulate active consumption, even in challenged shrimp; and ensuring optimal delivery of functional bacteria to the digestive system.

Hydrodynamic properties

The wafer format addresses fundamental limitations of traditional probiotic applications through its unique delivery mechanism. Slow-sinking wafers create an attractive, stimulating movement pattern that naturally draws shrimp's attention and triggers feeding responses.

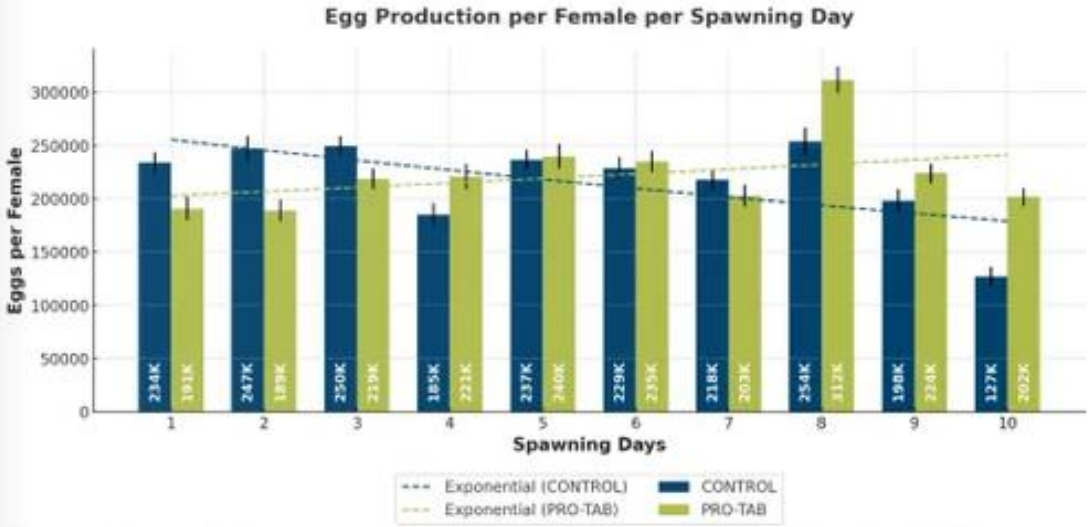


Figure 1. Egg production per spawning day in field trials conducted in Ecuador with Penaeus vannamei broodstock administered 0.4g of probiotic wafers per shrimp/day during a 30-day evaluation period.

Extended water stability testing reveals that wafers maintain structural integrity for multiple hours in aquatic environments. Even after three hours of submersion and exposure to gentle water currents, wafers retain their shape and functional properties. This controlled release ensures shrimp actively consume the wafers throughout the water column, maximising opportunities for consumption while maintaining structural integrity.

This targeted delivery approach enables "pulse applications" – periodic doses of high-concentration probiotics that rapidly influence gut microbiome composition. The concentrated nature appears more effective than continuous low-level exposure, as it can overwhelm pathogenic populations and establish beneficial bacterial communities more quickly.

Research results from commercial trials

Broodstock performance studies

Comprehensive field trials conducted in Ecuador have provided valuable quantitative data on the effectiveness of probiotic wafers in commercial aquaculture settings. In *Penaeus vannamei* broodstock facilities, researchers evaluated the impact of daily administration of 0.4g of probiotic wafers per shrimp during a 30-day evaluation period, during which multiple reproductive performance parameters were measured, using non-ablated females (Figure 1).

The results demonstrated statistically significant improvements across several key metrics. Survival rates of non-ablated females showed marked improvement with extremely high statistical confidence (p-value of 0.0000028), while daily copulation events nearly doubled from 5% to 9%. These reproductive improvements translated into measurable production gains, with egg production per female increasing by 6% and maintaining higher levels across consecutive spawning, while control groups showed declining egg production over time.

Total nauplii production demonstrated dramatic improvements, jumping by 37% compared to control groups. Perhaps most significantly from a biosecurity perspective, the use of probiotic wafers resulted in lower pathogenic bacterial loads in nauplii, providing healthier offspring for subsequent production stages and reduced *Vibrio* concentrations throughout the hatchery production cycle (Figure 2).

Comparative performance data

Field trials in Thailand using half-hectare ponds (22ppt salinity) demonstrated significant production improvements. Control ponds required 102 days culture period while Sanolife™ PRO-TAB treated ponds achieved harvest in 98 days with 14% higher yields.

Scientific mechanisms and mode of action

Bacterial colonisation and competition

The effectiveness of probiotic wafers stems from multiple biological mechanisms that work synergistically to improve both animal health and production outcomes. The *Bacillus* strains employed are spore-forming bacteria that possess the ability to survive environmental stresses and establish stable populations within the gut environment.

A very high concentration of viable bacteria delivered through each wafer enables rapid colonisation of the digestive tract through a "probiotic pulse " effect. This concentrated delivery approach appears significantly more effective than continuous low-level exposure because it can quickly establish beneficial bacterial populations that maintain themselves through normal reproduction and colonisation processes.

Laboratory studies demonstrated clear zones of inhibition around *Bacillus* cultures when challenged with various *Vibrio* isolates, with *B. pumilus* showing particularly strong antagonistic activity. This competitive exclusion effect helps maintain balanced intestinal microbiomes that favour beneficial bacteria over potentially harmful species.

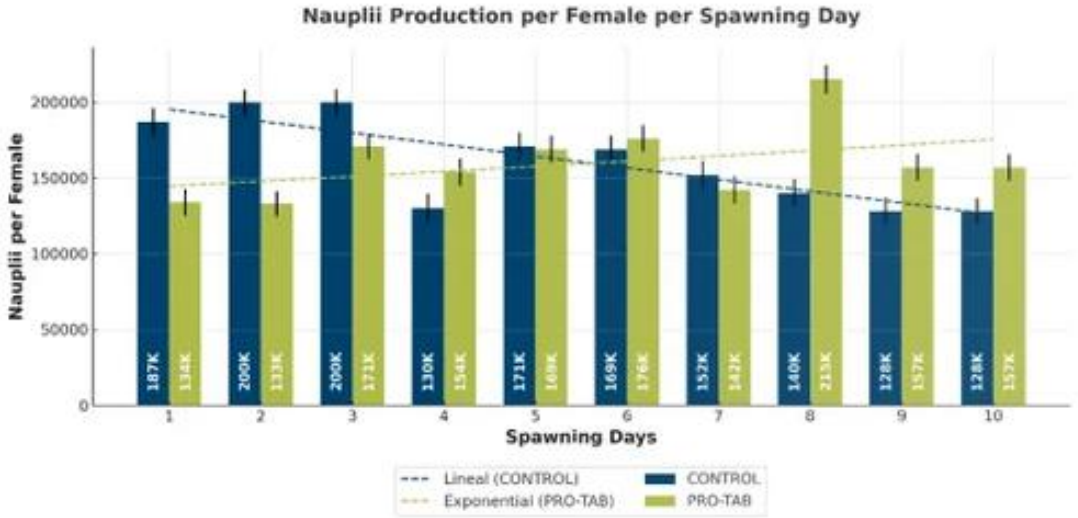


Figure 2. Nauplii production per spawning day in field trials conducted in Ecuador with *Penaeus vannamei* broodstock administered 0.4g of probiotic wafers per shrimp/day during a 30-day evaluation period.

Enzymatic activity and nutrient utilisation

Additionally, the selected *Bacillus* strains synthesise various digestive enzymes (both exoenzymes and endoenzymes) that improve nutrient absorption and feed conversion efficiency. This enzymatic activity benefits the host animal and contributes to reduced organic loading in production systems through more efficient nutrient utilisation.

Environmental bioremediation

The breakdown of organic matter by these bacteria extends beyond the gut environment, as viable bacteria continue to function even after passing through the digestive system, contributing to improved water quality in pond environments. Observations indicate that shrimp often carry consumed wafers to different pond areas, effectively distributing their parallel bioremediation activity throughout the culture system rather than concentrating it in traditional feeding zones.

Operational advantages and environmental benefits

Application simplicity

The transition from traditional powder-based probiotics to wafer formulations represents a significant innovation in probiotic application, offering operational simplicity for commercial aquaculture operations. Wafer-based probiotics eliminate many preparation steps required by traditional formulations, including mixing, suspension preparation, and timing considerations that can introduce variability in application protocols.

These ready-to-use wafers can be mixed directly with commercial feeds without additional preparation, making them compatible with both automated feeding systems and manual feeding protocols. The standardised wafer format eliminates calculation errors and ensures consistent dosing, removing human error factors that can compromise probiotic effectiveness.

Feeding behaviour modification

The attractive properties of wafers create additional management benefits beyond probiotic delivery. The highly palatable wafers encourage active consumption, potentially reducing bottom-feeding behaviour that can expose shrimp to sediment-associated pathogens and elevated *Vibrio* loads. This behavioural modification contributes to overall health management strategies.

Multi-species applications

While primarily developed for shrimp applications, the wafer format demonstrates versatility across multiple aquaculture species. Ongoing research in fish culture applications suggests broader potential for wafer-based probiotic delivery systems across diverse aquaculture operations.



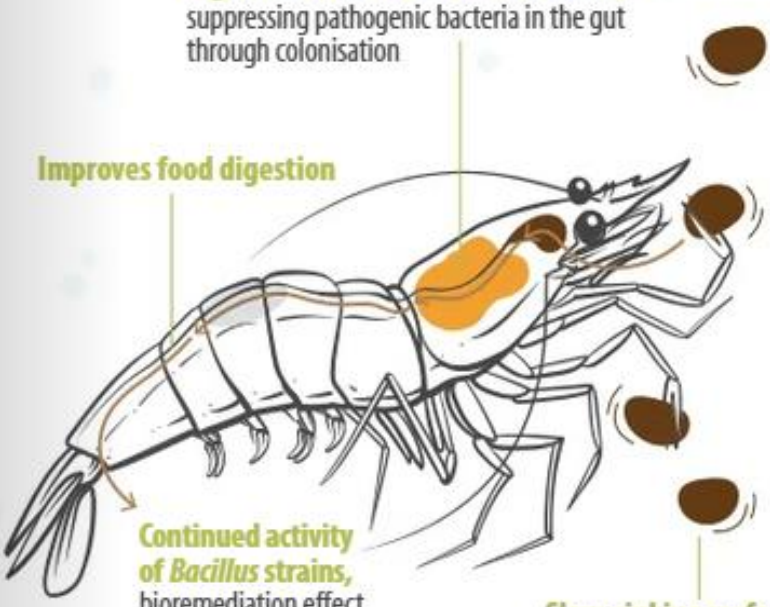
Sanolife™ PRO-TAB

INVE'S PROBIOTIC WAFERS: PROMOTING SHRIMP HEALTH FROM WITHIN

Probiotics with **high performance**, in edible and **slow-sinking wafers**, for shrimp culture

Ingestion of beneficial *Bacillus* strains, suppressing pathogenic bacteria in the gut through colonisation

Improves food digestion



Continued activity of *Bacillus* strains, bioremediation effect in water and soil

Slow-sinking wafers, attractive to all stages of shrimp

Dual action: Supports both shrimp gut and pond environment

Probiotic pulse: Targeted highly concentrated probiotic therapy

Effortless ingestion: Engineered to suit the shrimp's mandibular anatomy

High attractiveness: Eaten by shrimp, even when stress reduces appetite

Delivering 10^9 CFU/g



Available in two sizes:
2 mm: 445 wafers per gram
5 mm: 55 wafers per gram
(Averages of 3 replicates)

INVE AQUACULTURE

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CARE FOR GROWTH

Supports **sustainable** shrimp farming

Stress management

The water stability of probiotic wafers makes them particularly suitable for use during critical periods when shrimp may be under stress from environmental changes, handling, or disease pressure. Strategic applications during moulting cycles, transportation, or other stressful events can help maintain gut health and immune function when animals are most vulnerable.

Economic impact assessment

Field trial economics consistently demonstrate substantial profit improvements across diverse production systems. Trials conducted at multiple nursery sites with *P. vannamei* demonstrated economic benefits ranging from 12% to 54% above standard practices, with one notable case achieving returns that exceeded typical farm performance by more than half. These consistent economic gains across multiple sites in Ecuador validate the commercial viability of wafer-based probiotic systems and highlight their potential to transform aquaculture profitability while maintaining high standards of animal health and biosecurity.

Conclusion

Probiotic wafers represent a significant technological advancement in aquaculture management, offering improved probiotic delivery with demonstrated benefits in commercial settings. The enhanced application consistency and biological effectiveness of wafer formulations address many practical challenges faced by modern shrimp producers.

The combination of scientific innovation and practical application demonstrated in these systems illustrates the potential for technology to improve both animal welfare and production efficiency in aquaculture operations. The documented success in commercial trials, combined with operational advantages and environmental benefits, positions wafer-based probiotic systems as valuable additions to the toolkit available to modern aquaculture producers.

The integration of attractive design features, controlled-release mechanisms, and high-concentration bacterial delivery creates a paradigm shift extending traditional probiotic applications with a more targeted delivery system that supports both individual animal health and broader system-level including e.g. water quality management.



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