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Unveiling White Faeces Syndrome: A Multifactorial Threat to *Litopenaeus Vannamei* Shrimp Health and Production

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SUMMARY

White faeces syndrome has emerged as a formidable, multi-factorial gastrointestinal disorder emerges between 30 – 50 days of culture threatening the sustainability of Litopenaeus vannamei aquaculture particularly in high density tropical shrimp farms. It results from a complex interplay of microbial infections, environmental stress, poor pond ecology and toxic metabolite buildup in cultured ponds, marked by the presence of pale or milky white faecal strings appeared on the surface of water and hepatopancreas and gut become pale yellow in colour. By adopting integrated health approaches include probiotic supplementation, herbal therapeutics and zero exchange systems to stabilize the pond microbiota and controls the WFS occurrence in grow out ponds. Long term resilience requires an enhanced biosecurity, optimized feeding, and climate adaptive infrastructure.

INTRODUCTION

Litopenaeus vannamei dominates a global aquaculture, contributing over 75% of cultured shrimp output and projected to reach 7.33 million metric tons by 2025. In India, more than 1,08,526 hectares are under cultivation, with Andhra Pradesh accounting for over 60% of national production followed by Tamil Nadu, Orisa and Gujarat. Its widespread adoption is driven by its rapid growth, high feed conversion efficiency, and adaptability to intensive systems. However, this expansion is increasingly threatened by White gut disease (WGD) or White faeces syndrome (WFS), a multifactorial gastrointestinal disorder characterized by presence of floating white faecal strings, a pale and mushy hepatopancreas, poor swimming. WFS typically arises especially in high-density intensive culture ponds with poor water quality, excessive organic load, and unstable plankton dynamics. Histopathology reveals in WFS affected shrimps an abnormal clump of damaged microvilli-tinny, finger like structure lining has been swelled, stick together, and break off due to the gut infection or stress and they accumulated in the digestive tract and expelled as white, Further the epithelial lining of the digestive tract becomes inflamed and detached from basal membrane. This disrupts the gut barrier, reduces digestive efficiency and allow pathogen or toxins to invade deeper tissues. Key pathogens include *Enterocytozoon Hepatopenaei*, *Vibrio* spp., and viruses like WSSV, TSV, and IHHNV, often exacerbated by ammonia, nitrite, and hydrogen sulphide accumulation. In severe outbreaks, WFS can cause up to 60% yield loss, threatening both farm viability and export reliability.

Figure 1: White faecal strings floating on water.

Disease occurrence

WFS tends to surface like a hidden tide in shrimp ponds, typically between 30 to 50 Days of Culture (DOC) a critical window when shrimp metabolism intensifies and pond ecology becomes fragile. In some cases, subtle signs such as floating white faecal strings may appear as early as 20–30 DOC, especially under environmental stress. Rainy season exacerbate WFS outbreak due to abrupt changes in temperature, salinity, and Dissolved oxygen, which mostly destabilize pond equilibrium and stress shrimp physiology. monsoon linked fluctuations often coincide with phytoplankton crashes and increasing the sludge formation it creates an anaerobic condition that favours the proliferation of pathogens in the pond. Further the environment instability leads to weakens the shrimps and it also accelerates the onset and severity of WFS in high stocking pond systems. WFS has carved a path through India's aquaculture heartlands, with high incidence in Andhra Pradesh's coastal districts such as: West Godavari, Prakasam, Nellore, and East Godavari and Tamil Nadu's shrimp belts including: Nagapattinam, Cuddalore, and Ramanathapuram. Beyond India, Sri Lankan farms cultivating *Penaeus monodon* have reported mortality rates soaring up to 30%, underscoring the transboundary nature of this multifactorial disease.

Clinical manifestations

WFS in *Litopenaeus vannamei* is a multifactorial shrimp health disorder typically manifests as pale, milky faecal strings an alarming deviation from the typical dark compact excreta observed from healthy shrimp. This system reflects internal gastrointestinal distress, often triggered by viral, bacterial, or parasitic agents, most notably the microsporidian *Enterocytozoon hepatopenaei* (EHP) and this condition further exacerbated by environmental stressor includes elevated ammonia and nitrite levels, salinity level and suboptimal water quality. WFS affected shrimp often exhibit lethargy, anorexia, stunted growth, weak swimming, and in severe cases, shell deformities and reproductive failure may occur. The presence of excess mucus, shed epithelial cells, and undigested feed in faeces reflects compromised digestive and absorptive functions. If left unmanaged, WFS can escalate to high mortality rates and substantial economic losses. Early detection through faecal colour changes, coupled with diagnostic screening and real-time water monitoring, is vital.

Drivers of WFS onset

WFS arises from a complex interplay of environmental, nutritional, microbial, and climatic factors that disrupt digestive health and destabilize the pond ecology. Sludge accumulation from faeces, uneaten feed, and dead phytoplankton elevates biological oxygen demand (BOD), fosters harmful metabolite buildup, and triggers plankton blooms that destabilize pH and oxygen levels. Inadequate pond bottom management and inefficient aeration promote anaerobic conditions, releasing toxic gases like ammonia, nitrite, and hydrogen sulphide leads to damages the gut lining. Overfeeding and low-quality feed contribute to undigested organic waste settled at the pond bottom becomes a substrate for microbial proliferation, and increasing the pathogen load and promotes growth of harmful bacteria. Opportunistic Bacterial infections especially *Vibrio* species (*V. harveyi*, *V. alginolyticus*, *V. parahaemolyticus*) and *Aeromonas* invade the digestive tract and induce inflammation, epithelial erosion and tissue necrosis. Concurrently, Viral agents such as WSSV, TSV, IHHNV, and HPV impair hepatopancreatic function, leading to white faeces discharge and high mortality. Parasitic intruders like microsporidia and ciliates further impair digestion by damaging the gut epithelial structures.

Recovery Dynamics

The recovery process from WFS in *Litopenaeus vannamei* exhibits significant variability, influenced by the infection's severity, the specific pathogen involved, and the promptness and efficacy of management strategies. This recovery generally progresses through three distinct phases. During the initial phase, noticeable improvements in faecal colour, swimming patterns, and appetite may be observed within 7 to 14 days, provided that corrective actions such as probiotic supplementation, regulated water exchange, and dietary modifications are implemented without delay. Herbal treatments, including Citrus limon, Allium sativum, and Zingiber officinale, have demonstrated potential in expediting gut recovery and decreasing pathogen levels, particularly in cases classified as mild to moderate. The functional recovery phase, which encompasses the regeneration of the hepatopancreas, repair of microvilli, and rebalancing of the immune system, may extend up to four weeks, especially in ponds suffering from sludge accumulation or inadequate aeration. Nevertheless, recovery may be hindered or remain incomplete in high-density aquaculture systems or during monsoon-related stress, resulting in persistent impacts on growth rates, feed conversion efficiency, and uniformity of market-grade products. In

instances of severe outbreaks, farmers might be compelled to undertake emergency harvests, thereby sacrificing the potential for complete recovery in order to minimize economic losses and avert further decline.

Economic impact

WFS has caused an estimated ₹1,022.1 crore in economic losses to India's shrimp aquaculture sector, disrupting over 2.15 million man-days of labour and compromising nearly 48,700 metric tonnes of production. Affected farms 20–30% drops in harvest value due to stunted growth, poor feed conversion, and downgraded shrimp quality. The WFS outbreaks are forced to implement cost intensive measures such as: Emergency harvests, pond disinfection, and probiotic treatments inflate operational costs, while inconsistent shrimp sizes erode buyer confidence and export reliability. Small and medium scale farmers face shrinking profit margins and limited reinvestment capacity. The ripple effects extend to supply chain delays, contract losses, and seasonal income instability in coastal regions like Andhra Pradesh and Tamil Nadu. Disease management costs biosecurity upgrades, water monitoring, and herbal alternatives add financial strain. Further, Antibiotic use raises concerns over residue and antimicrobial resistance, threatening compliance with internation food safety standards. In severe outbreaks, yield losses may reach 60% and in extreme case with total crop rejection in extreme cases. WFS has destabilized India's shrimp production ecosystem, undermining long-term sustainability and investor trust.

CONCLUSION

WFS stand as a formidable barrier to the long-term sustainability of *Litopenaeus vannamei* aquaculture, both in India and globally. Its multifactorial nature rooted in microbial infections, poor pond ecology, and climatic volatility demands a holistic, adaptive management approach. Indian shrimp farmers are responding with integrated health strategies, including zero water exchange systems to stabilize microbial communities, locally sourced probiotic supplementation like *Bacillus subtilis* to enhance gut health, and herbal therapeutics from *Citrus limon*, *Allium sativum*, and *Zingiber officinale* exhibits an antimicrobial and hepatoprotective properties. However, abrupt temperature shifts and erratic rainfall continue to amplify disease vulnerability, especially in high-density culture systems. Strengthening biosecurity protocols, optimizing feed protocols, and reducing antibiotic dependence are essential to protect farm viability. Future resilience will depend on real-time diagnostics, climate-adaptive pond infrastructure, and microbiota-based disease prevention. A coordinated effort across research, policy, and farmer education is vital to safeguard India's shrimp aquaculture from the recurring threat of WFS.

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