

intermolt periods and accelerates growth, but excessive heat becomes inhibitory: in crablets, 30°C improved molting frequency, growth, and feeding, whereas 34°C significantly reduced ecdysis frequency and slowed growth (Macario et al., 2025). A similar threshold pattern is evident during embryogenesis, where development remained normal at 27°C-29°C, but 31°C-33°C caused asynchronous development, diapause, increased mortality, and sharply reduced hatching success (He et al., 2022).

Current molecular evidence indicates that temperature affects molting through endocrine and metabolic regulation rather than through growth alone. In *P. trituberculatus*, silencing either TRPA1 paralog significantly prolonged the molting interval, and abnormal temperatures altered molting timing through changes in endocrine regulators and metabolic enzymes (Qian et al., 2025). Because successful molting also depends on intact molt signaling and adequate nutritional support, any heat-induced disruption of endocrine coordination is likely to interact with other culture stressors; consistent with this, cholesterol nutrition promotes ecdysone signaling, molting rate, and growth, indicating that growth retardation under heat stress is closely tied to impaired molting physiology rather than to reduced size gain alone (Zhu et al., 2022).

5 Key Health Management Techniques

5.1 Water quality regulation and farming environment optimization techniques

Under high-temperature conditions, water quality regulation should prioritize the stabilization of temperature, dissolved oxygen, pH, and ammonia, because rapid fluctuation in these parameters increases mortality risk and disease susceptibility in aquaculture systems. In swimming crab culture, prolonged summer deterioration of seawater quality can lengthen water-exchange intervals and expose crabs to sustained ammonia stress, while broader aquaculture evidence shows that instability in dissolved oxygen, pH, and temperature directly elevates the risk of production loss. (Lu et al., 2022; Flores-Iwasaki et al., 2025). Ammonia control and ecological optimization are especially important in intensive ponds during hot periods. In *Portunus trituberculatus*, long-term ammonia exposure above 15 mg/L for 15 days severely damages the hepatopancreas and compromises cellular stress responses, indicating that high-temperature management must include measures that reduce organic loading and improve nitrogen processing. Integrated pond regulation can help: nutrient-dynamics modeling showed that residual feed released 41.43% of total feed-derived carbon to the water, while adding razor clams at an appropriate density improved comprehensive water quality in swimming crab-shrimp systems (Lu et al., 2022; Yao et al., 2025).

5.2 Nutritional fortification and immune enhancement strategies

High temperature disrupts nutrient metabolism, increases oxidative stress, and suppresses immune function in crabs, so dietary fortification should focus on antioxidant and immunomodulatory additives. Evidence from chronic heat-stress experiments in crabs shows that elevated temperature increases reactive-oxygen-species-related damage and depresses survival, whereas nutritional intervention can partly restore antioxidant defenses and immune performance (Liu et al., 2023; Wang et al., 2024). Among the tested additives, yeast culture and targeted amino acid or vitamin supplementation appear especially promising for heat-stress mitigation. In juvenile Chinese mitten crab, 3.2 g/kg yeast culture improved survival, antioxidant enzyme activity, immune indices, and gut integrity under chronic heat stress, while high dietary methionine improved survival and reduced oxidative stress and apoptosis at 30°C; similarly, vitamin C at about 133.94-144.81 mg/kg enhanced nonspecific immunity and antioxidant capacity in mud crab. These findings support the use of fortified diets to maintain physiological resilience in swimming crab farming during hot seasons, although direct validation in *P. trituberculatus* under pond heat stress is still limited (Wang et al., 2024).

5.3 Intelligent monitoring and precision farming management techniques

Intelligent monitoring is increasingly central to high-temperature aquaculture management because manual sampling cannot detect sudden changes in temperature, dissolved oxygen, pH, and ammonia quickly enough for timely intervention. Reviews of aquaculture IoT systems show that real-time sensor networks improve growth, reduce mortality, and enable rapid detection of atypical water-quality conditions, while low-cost monitoring platforms can provide continuous parameter tracking with reduced labor input (Shete et al., 2024; Flores-Iwasaki et