

share limited feeding space, while dominance-related differences in feeding time are reduced (Bardera et al., 2021). Turbidity alters group-level responses, with higher turbidity increasing feed intake and reducing distances between individuals, suggesting that commercial ponds with naturally turbid conditions may promote more cohesive and intense feeding bouts than clear-water tanks (De Tailly et al., 2025).

Mechanistic diagram of the effects of temperature gradient on the feeding behavior of *Litopenaeus vannamei*

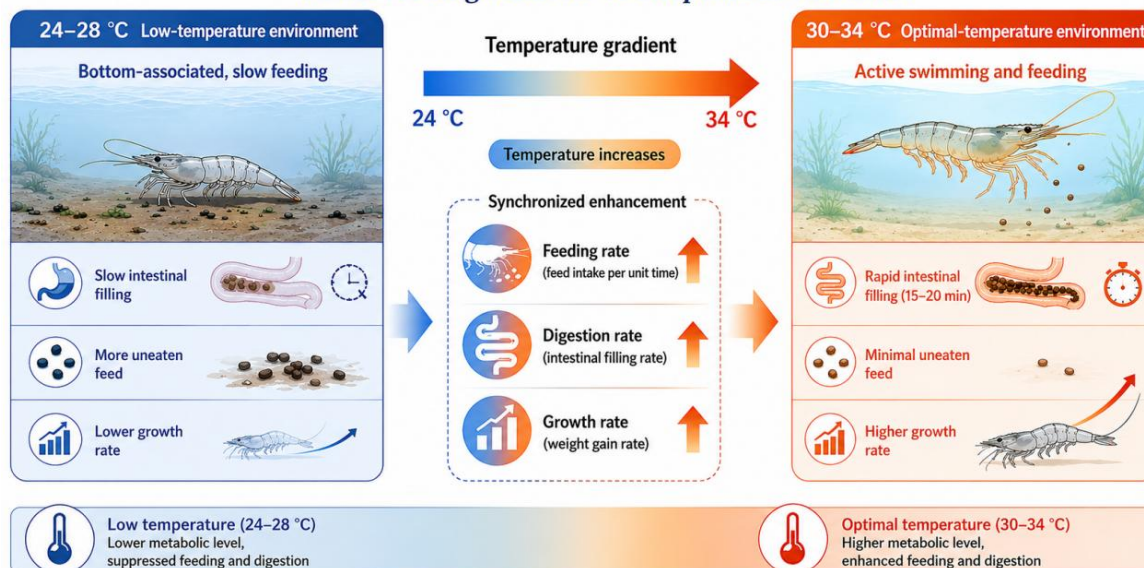


Figure 1 Effects of water temperature on feeding behavior, digestive activity, and growth performance of Pacific white shrimp (*Litopenaeus vannamei*)

Note: Shrimp reared at 24 °C-28 °C exhibit slower feeding activity, prolonged gut-filling and evacuation times, and increased feed residues, whereas individuals maintained at 30 °C-34 °C show rapid feed consumption, accelerated digestion, and enhanced growth

2.3 Relationship between feed utilization efficiency and growth performance

Feed utilization efficiency, commonly expressed as feed conversion ratio (FCR), is tightly linked to growth performance and is influenced by diet formulation and feeding rate. In intensive systems, increasing feeding rates above a standard schedule leads to higher final weights, but FCR worsens and growth approaches a plateau, revealing an inflection point near 100%-101% of the standard feeding rate where additional feed yields diminishing returns. Trials manipulating feeding frequency in juveniles similarly show that moderate automatic feeding (around 6-8 meals per day) improves FCR, final weight, and antioxidant status compared with less frequent manual feeding, indicating that spreading the same ration into more meals can enhance nutrient utilization (Liang et al., 2025).

Dietary interventions that improve digestion or metabolic efficiency can reduce FCR while supporting growth. Supplementation of low-fishmeal, low-lipid diets with small amounts of lysophospholipids increases final body mass, growth rate, and protein deposition, while lowering FCR and enhancing digestive enzyme activities and intestinal health, demonstrating how additives can “unlock” feed efficiency under cost-saving formulations (Li et al., 2026). Similarly, nanoemulsified curcumin in olive oil has been shown to improve specific growth rate, FCR, and protein efficiency ratio, alongside better digestive enzyme secretion and antioxidant capacity, linking enhanced physiological status to more efficient feed use (El-Bab et al., 2024).

3 Common Feeding Strategies and Their Characteristics

3.1 Fixed-time and fixed-quantity feeding strategy

In many commercial farms, shrimp are fed at fixed times and fixed daily rations based on biomass estimates or standard feeding tables. This approach is simple to implement and relies on scheduled distributions (for example, two to four meals per day) with predetermined quantities that are adjusted periodically as shrimp grow. Semi-intensive pond trials using standard feeding protocols (SFP) show that applying a fixed ration close to a