



ALLIANCE™

(<https://www.globalseafood.org>).



Health &
Welfare

Effect of feeding Pacific white shrimp with fresh green macroalgae *Chaetomorpha clavata*

16 September 2024

By Dr. Emanuelle Pereira-Borges

Results show that shrimp mortality, growth rates and energy budget were unaffected by the inclusion of algae in the shrimp feed



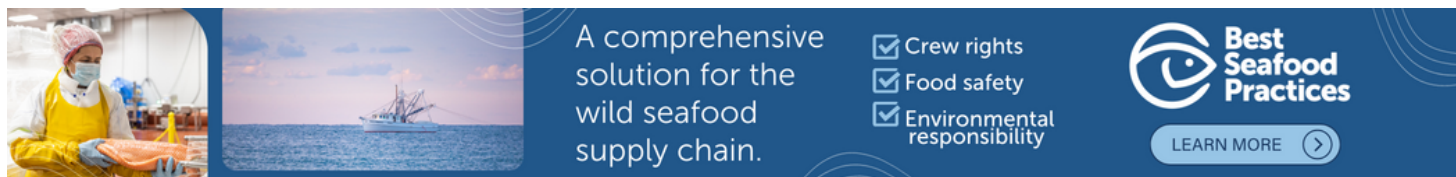
This study investigated the effects of effect of feeding Pacific white shrimp with fresh green macroalgae *Chaetomorpha clavata*. Results showed that shrimp mortality, growth rates and energy budget were unaffected by the substitution of 50 percent algae in the shrimp feed and that this feed replacement level with *C. clavata* can be is a viable alternative to reduce feed costs in *P. vannamei* culture, making it a potential candidate for co-cultivation with shrimp Photo of *Chaetomorpha* sp. by I, Channer (CC BY-SA 3.0, <http://creativecommons.org/licenses/by-sa/3.0/>, via Wikimedia Commons).

The use of dried marine macroalgae as a food supplement incorporated into commercial aquafeeds has been widely studied for some farmed species because they are an important source of nutrients such as amino acids, omega-3 and omega-6 fatty acids, as well as antioxidants and antimicrobials.

The genus *Chaetomorpha* comprises 77 species of marine and brackish water green algae, several of which grow in stagnant waters, including aquaculture ponds, aqueducts, and reservoirs. These algae can grow in salinities from freshwater to 90 ppt, have a wide tolerance to temperature variations from 20.1 to 40.9 degrees-C and high growth rates. Species of algae within this genus also exhibit a diversity of active antibacterial and antioxidant properties. Moreover, they act as biofilters, and as such have great potential for treating effluent water by removing nitrogen and phosphorus. Thus, the inherent characteristics of species within this genus could prove useful for aquaculture operations, and especially in **IMTA systems** (<https://doi.org/10.1111/raq.12580>).

One species, *C. clavata*, is particularly widespread geographically, occurring in North America (Florida and the Gulf of California), Central and South America (Brazil, Chile, Colombia and Venezuela), Africa and Asia. The use of this macroalga for feeding farmed shrimp like the Pacific white shrimp (*Litopenaeus vannamei*) has not yet been reported.

This article – **summarized** (<https://creativecommons.org/licenses/by/4.0/>), from the **original publication** (<https://doi.org/10.1016/j.aqrep.2024.102222>) [Pereira-Borges, E. et al. 2024. Physiological effects of feeding whiteleg shrimp (*Penaeus vannamei*) with the fresh macroalgae *Chaetomorpha clavata*]. *Aquaculture Reports*, Volume 37, August 2024, 102222) – reports on a study to determine if *P. vannamei* would feed on *C. clavata* and assess shrimp mortality and growth, along with several additional physiological characteristics (ingestion, molting, metabolism, nitrogen excretion, oxidized energy substrate, hepatosomatic index, and energy budget), of shrimp fed a diet consisting of 50 percent of this macroalgae.



(<https://bspcertification.org/>).

Study setup

Juvenile *P. vannamei* (4.36 grams \pm 0.40) shrimp collected from shrimp farms in the state of Santa Catarina, Brazil, were transported to the Sustainable Aquaculture Laboratory, São Paulo State University (UNESP) in São Vicente, Brazil. After the acclimation period to the laboratory, the animals were weighed and divided into two groups, with 8 animals (N = 8) per treatment: treatment 1 (control) were animals fed only with commercial feed; and treatment 2 (feed + macroalgae) included animals fed 50 percent commercial feed and 50 percent fresh *C. clavata* macroalgae cultured in the Laboratory of Algae and Aquatic Plants, UNESP.

The shrimp were reared for 25 days in individual aquariums with aerated water with 25 ppt salinity, temperature of 25 degrees-C and 12-hour light:12-hour dark photoperiod. Ingestion and egestion, oxygen consumption and ammonia excretion were evaluated. Animals that at the end of the experiment were in the pre- or post-molt stage were excluded because such stages could cause changes in physiology, including body mass due to the high percentage of body hydration.

For detailed information on the experimental design, animal husbandry, data collection and analyses, refer to the original publication.

Potential marine resources to sustainably meet aquafeed ingredient demands



Transitioning of aquafeeds from linear to circular models involves the potential valorization of a wide range of marine resources.



Global Seafood Alliance

Results and discussion

Results showed that replacing 50 percent of the commercial feed with fresh algae had no effect on the growth or mortality rates of *P. vannamei* shrimp, nor did it lead to any notable changes in physiological parameters (metabolism, ammonia excretion, hepatosomatic index and energy budget). Based on these results, we propose that this substitution could be advantageous considering that it offers significant economic and environmental benefits because commercial feed is the most expensive production cost in aquaculture operations.

Ensuring proper animal nutrition is one of the most important factors in aquaculture because it affects the survival, growth, and health of the farmed species. We observed that the mortality rates of control animals and those given a diet of commercial aquafeed and algae were statistically similar, although there was a tendency for the latter to have a higher rate, possibly due to the number of replicates. In general, integrated cultivation of *P. vannamei* and algae can enhance shrimp survival and growth, while at the same time improving water quality. Although in our study we replaced 50 percent of the commercial feed with fresh macroalgae, future studies should assess whether a lower replacement level would be more suitable for *P. vannamei* culture, since other researchers have reported that higher percentages of feed replacement with algae can have a negative effect on survival.

Under natural conditions, *P. vannamei* shrimp is an omnivorous and opportunistic feeder with a diverse diet, indicating that it is capable of digesting most types of nutrients; indeed, analysis of wild *P. vannamei* stomach contents reveal that the animal feeds on a wide range of zooplankton, diatoms, filamentous algae and marine macroalgae. Moreover, crustaceans produced carbohydrate-degrading enzymes, further supporting the view that they rely on plants as a primary food source. We observed that *P. vannamei* ingestion rate increased following the substitution of 50 percent algae in their feed, a result similar to those found in other studies for this species provided feed supplemented with various green algae species.

This increase in ingestion rate could be attributed to several factors, including that green algae produce dimethyl sulfonyl propionate, a compound that can act as an attractant to some animals, consequently increasing consumption. Also, morphological characteristics such as the thickness, size, and shape of the algae thallus may play a role; for example, the thin thalli of *C. clavata* may have facilitated its consumption by *P. vannamei*.

Green macroalgae can promote crustacean growth due to the presence of certain proteins, free amino acids, and antioxidant complexes; however, no differences in growth rate were detected between animals fed a diet of full commercial feed and those fed a diet containing 50 percent fresh algae. Although our findings provide positive indications regarding the use of fresh *C. clavata* in the diet of *P. vannamei*, we suggest that substitutions of less than 50 percent should be assessed to determine whether lower levels promote even better growth results.

Although fundamental parameters for the cultivation of *P. vannamei* like survival, feeding, and growth were unaffected by the partial replacement of commercial feed with algae, other physiological data provide additional information on how energy is being used by the animals. Of these, oxygen consumption, nitrogen excretion, hepatosomatic index, and energy budget are good indicators of the energy flow needed for growth, survival and reproduction. Our results suggest that introducing fresh algae to the diet did not alter *P. vannamei* oxygen consumption and ammonia excretion; indeed, proteins were the main energy substrate oxidized regardless of the presence of algae in the diet.

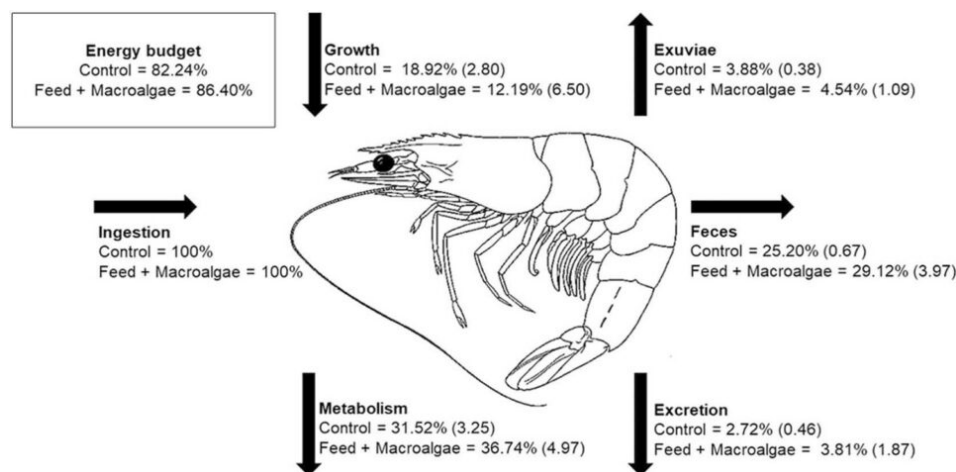


Fig. 1: Energy budget (expressed as a percentage of ingested energy) in shrimp *P. vannamei* fed with commercial feed (Control) or 50 percent commercial feed + 50 percent macroalgae *C. clavata*. Values with different letters in the same category differ statistically by T-test followed by SNK test. Adapted from the original.

Assessment of hepatopancreatic function using the hepatosomatic index enables the identification of changes in the use of stored energy triggered by disruptions in homeostasis or consumption of unbalanced diets containing insufficient energy. We detected no changes in the hepatosomatic index of *P. vannamei* shrimp fed a 50 percent algae diet, suggesting that replacing half of the commercial feed with seaweed has no effect on the shrimp's energy reserves. This is a crucial result because dietary changes should not lead to reductions in energy available for circumstances that increase energy demand, such as the introduction of abiotic stressors or reproduction.

Although diet is the main factor responsible for altering a species' energy budget, the results of our analysis indicated that the partial replacement of feed with algae did not affect the energy budget of *P. vannamei*. In this species, 62 percent of all energy ingested is channeled into metabolism or feces (~35 percent and ~27 percent, respectively) and a small proportion (~16 percent) is channeled into growth.

This seems to be a typical result for marine shrimp because other authors have shown that in shrimp such as *P. vannamei* and black tiger shrimp, *P. monodon*, the percentage of energy channeled into growth varies between 12 percent and 23 percent of the energy ingested. Although various studies may suggest that responses are species-specific, they also highlight the importance of using an appropriate diet for maintaining the proper energy budget for farmed species.

Perspectives

The present study is the first to demonstrate that *P. vannamei* shrimp feeds on the macroalgae *C. clavata* in the laboratory. Results show that substituting 50 percent of the feed with this macroalga represents a potential alternative to supplement commercial aquafeeds. In addition to the economic benefit of reducing the amount of feed used during culture, its use could also improve the quality of effluent water, thereby improving environmental sustainability and water quality.

Author



DR. EMANUELLE PEREIRA-BORGES

Corresponding author

Aquaculture Center of UNESP (CAUNESP), São Paulo State University (UNESP), Jaboticabal, SP
14884-900, Brazil

emanuelle.borges@unesp.br (<mailto:emanuelle.borges@unesp.br>).

Copyright © 2024 Global Seafood Alliance

All rights reserved.