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Nutritional Requirement of Shellfish Larvae

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SUMMARY

Aquaculture has emerged as a critical solution to meet the growing global demand for high-quality food, particularly fish and shellfish, as wild fisheries face limitations. The increasing popularity of shellfish has spurred the expansion of commercial shellfish farming, which relies heavily on nutritionally balanced and economically viable artificial feeds. However, the incorporation of suitable indigenous live feed, such as microalgae and zooplankton, is essential to enhance finfish and shellfish farming. These live feeds offer unique biochemical profiles that support the growth and survival of larval stages. Shellfish larvae exhibit various anatomical and physiological adaptations, particularly in their digestive systems, to optimize nutrient absorption as they transition from herbivory to carnivory. The nutritional requirements of shellfish larvae, particularly in terms of protein, carbohydrates, and fats, are crucial for their development. Microalgae serve as an important natural feed, offering a sustainable and cost-effective source of protein and other essential nutrients. Similarly, zooplankton is utilized to supplement larval diets, though it often requires enrichment with microalgae to meet the nutritional demands of shrimp larvae. While artificial feeds are commonly used from the juvenile stage onward, there is a growing emphasis on developing alternative diets that reduce dependence on wild-caught fishmeal and fish oil. Future research and innovation in larval nutrition hold the potential to promote sustainable aquaculture practices, ensuring the long-term survival and profitability of the shellfish industry.

INTRODUCTION

A focus on aquaculture growth resulted from the world population expanding rapidly to satisfy the demand for high-quality food. Fish and shellfish contribute more due to aquaculture's massive output. Aquaculture is in high demand in the future, as evidenced by its expansion in terms of ongoing production. Due to the growing popularity of shellfish and the need to boost production, commercial shellfish farming depends on the supply of artificial feed that is both economically viable and nutritionally appropriate. This is because a diet rich in essential nutrients promotes good animal growth and survival.Nutritionally, suitable indigenous live feed must be mass-cultured to improve finfish and shellfish farming. A vast array of aquatic animals that can be cultivated could potentially eat planktonic creatures, including copepods, infusorians, rotifers, cladocerans, and microalgae. It is possible to support the normal growth and survival of cultivable species larvae by utilizing the unique biochemical profile of these live prey's size range and nutritional value.

Anatomical adaptations in shellfish

While the development of spination and grinding surfaces on the mandibles of larval crustaceans can be linked to eating habits, The functional anatomy of the gut exhibits notable adaptations as it transitions from herbivory to carnivory. Early-stage penaeid protozoa that rely on phytoplankton as a food source typically have a larger digestive secretory area compared to larger carnivorous larvae with respect to stomach volume. As the larvae grow and transition to carnivory, the secretory region shrinks, corresponding with the anterior midgut diverticula's regression. The hepatopancreas and gland filter grow concurrently toward the adult functional morphology during the later larval stages. In contrast, giant carnivorous larvae like homarid lobsters have these characteristics formed when they hatch. It is evident that(specify AMD)plays a significant secretory role. They also show evidence of an adaptation to herbivorous feeding, as they lack carideans and appear vestigial in brachyuran and homarid larvae.

Digestive enzymes

Compared to adults, crustacean larvae seem to rely on a smaller range of digestive enzymes at comparatively high activity levels.This partially reflects a shorter history of studies on the physiology of larval digestion. All species that have been investigated thus far have been found to include the major proteases, carbohydrases, and lipases, with high levels of trypsin-like protease being particularly significant. It has been suggested that when food is abundant, as in the circumstances commonly encountered in the culture of crustaceans, the levels of digestive enzymes decrease because the body can meet its energy needs without requiring exceptionally effective digestion. In contrast, this model suggests that greater digestive enzyme content may be seen with lower dietary or specific nutrient availability levels but above the threshold of starvation.This could be the reason why the protease content of herbivorous and omnivorous organisms, including penaeid protozoea and mysis larvae, is higher than that of carnivorous organisms, like carideans and homarids. Depending on the composition of their diet, omnivorous larvae within a species may also have a broad range in protease content. For instance, compared to larvae given a low-protein algal diet, *Marsupenaeus japonicus* mysis larvae fed on protein-rich zooplankton exhibit a very noticeable decrease in protease concentration.

Nutritional requirement of Shellfish larvae

Types of shellfish larvae	Protein(%)	Carbohydrate(%)	Fat(%)
Penaeus monodon	48-52%	24-33%	8%
Penaeus japonicus	45-55%	15-25%	8-16.6%
Penaeus indicus	40-40.8%	24.5-27.9%	8.9-13.3%
Penaeus vannamei	52.7%	13.5%	11.5%
Penaeus setiferus	52.7%	12%	17%
Macrobrachium rosenbergii	46.1-57%	29.6-37%	37.4%
Homarus americanus	57%	12-15.7%	12-19%
Scylla serrata	55%	14%	6%

Natural feed requirements for the shellfish larvae

Shellfish larvae are fed natural feed due to their high nutritional content and adaptability to their characteristics. The natural feeding of larvae boosts antimicrobial action, growth, and survival while also improving metamorphosis success, supplying natural colour, and enhancing growth. Microalgae and zooplankton are the typical natural feeds used especially in shrimp production.During the nauplius VI stage to protozoea stage, shrimp larvae are fed microalgae as their first food, and during the mysis to post-larval stages, they are fed zooplankton.Natural feeding of shrimp larvae is dependent on variations in morphology and behavior.

Microalgae as natural feed

Microalgae play an important role in aquaculture, helping to ensure the viability of cultivation. In aquaculture, the sustainability of microalgae bringsnot just technical improvements but also financial gains (Han et al. 2019). This is further supported by Aftab et al. (2021), who reported that microalgae are utilized in the marine biota cultivation industry for a variety of purposes, such as natural food for fish, molluscs, and shrimp larvae. The fact that protein comprises approximately the majority of an algae's composition, with fat and carbs coming in second, highlights the significance of microalgae as feed for aquaculture. According to Noerdjito (2019), the typical ranges for microalgae's protein levels are 12–35%, lipid content is 7.5-23%, and carbohydrate content is 4.6-23%. For the marine biota, especially during the larval stage, microalgae containing long-chain polyunsaturated fatty acids (LC-PUFA) are essential sources of nutrition. The different species of microalgae have different nutritional contents (Adams et al. 2013). Larvae require protein as a source of energy and necessary amino acids. One of the components of feed also includes protein. which, in comparison to other nutrients included in feed, is the most expensive. (Pina et al. 2005). Roy and Pal (2015) offered more support for this claim, stating that about 40% of the feed's cost is devoted to meeting the protein requirements of shrimp larvae. subsequently fats and carbs. Because of the increased need for protein, there is a need for alternate diets that are both high in protein and can lower feed costs. Microalgae are recognized as a non-leaching source of protein that can save feed expenses. Additionally, as Rajeswari and Balasubramanian (2014) noted, choosing microalgae with the highest protein content will enable manufacturers to lower feed costs by combining them with other feed sources while preserving digestibility to guarantee shrimp growth. Not every kind of microalgae can be fed to shrimp in order to sustain their growth and survival during culture activities. Various kinds of microalgae are chosen as feed based on the nutritional requirements and stages of shrimp development.

Types of microalgae	Protein (%)	Carbohydrate (%)	Fat (%)
Chlorella vulgaris	51-58	12-17	14-22
Dunaliella salina	47-55	29-32	6
Tetraselmismaculata	49-52	15	3
Spirulina maxima	55-68	16	7
Euglena gracilis	40-61	14-18	20
Pavlova Iutheri	32	9	12
Chaetoceros mulleri	50	17	5
Skeletonema costatum	32	19-22	8
Anabaena cylindrica	43-56	19	5

Zooplankton as Natural Feed

Many have suggested using zooplankton as a high-nutrient substitute for natural feed in shellfish especially in shrimp culture (Campaña-Torres et al. 2010). To increase shrimp production, feed must be regularly improved in terms of its nutritional content (Ayisi et al. 2017). This has to do with the fact that shrimp have higher nutritional requirements as they grow (Kandathil Radhakrishnan et al., 2020). Because feeding zooplankton lacks vital nutrients, it is thought to be insufficient for meeting the nutritional needs of shrimp larvae. to enhance the nutritional value of feed by employing microalgae to enrich zooplankton (Samat, Yuso, & Rasdi 2020). According to Brito et al. (2004), the following species of zooplankton can be fed to shrimp in order to encourage their growth: Artemia sp., Brachionus sp., Moina sp., and Dhapnia sp.

Artificial Feed as Shrimp Feed

In shrimp culture, artificial feed frequently given from the juvenile to the adult stage. Artificial feed helps fulfill predators' requirements for feed size and reduce issues and risks related to supplying live feed. Additionally, it is considered to be more successful (Lavens et al. 1999). Labrador, Guiñares, and Hontiveros (2016) have provided support for this idea, indicating that the management of artificial feed may improve overall physiological conditions and increase resistance to disease. The three stages of artificial feed used in shrimp culture are starter, grower, and finisher. Each stage's feed is managed for a specific reason.

Future perspectives of shellfish larvae nutrition

The feeding of shellfish larvae has tremendous potential to promote sustainable aquaculture in the future. An increasing amount of study is going into producing alternative diets that are high in vital nutrients to improve the quality, growth, and health of shellfish larvae. The industry aims to improve the nutritional profile of oyster larvae diets while decreasing demand on wild-caught fishmeal and fish oil by investigating substitute ingredients such microalgae, marine proteins, and probiotics, as well as improving feeding techniques. These programs promote the preservation of marine habitats and resources in addition to promoting the sustainable production of quality shellfish.Furthermore, improvements in the study of larval nutrition open the way to more stable and efficient techniques for feel farming, assuring the industry's long-term survival and profitability over environmental challenges and changing consumer tastes.

CONCLUSION

In conclusion, there is wish for the future of feeding shellfish larvae in terms of improving sustainable aquaculture. The goal of efforts to produce alternative diets high in essential nutrients is to improve the health, growth, and quality of shellfish larvae by decreasing dependent on fish oil and fishmeal obtained from wild fish. The industry works to protect marine environments and resources while maintaining the sustainable production of high-quality shellfish. It does this by studying alternatives including microalgae, marine proteins, and probiotics, as well as improving feeding practices. Additionally, improvements in the study of larval feeding open the way to safer and more efficient farming methods, ensuring the industry's long-term survival and profitability in the face of shifting customer tastes and environmental problems. When everything is considered, these applications are vital beginnings toward making sure shellfish farming has a more strong and sustainable future.

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