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Editorial: Advances and perspectives in integrated multi-trophic aquaculture

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Editorial on the Research Topic
Advances and perspectives in integrated multi-trophic aquaculture

Aquaculture continues to be the agroindustry with the highest growth rate worldwide. While fisheries (in continental or marine waters) did not grow in practical terms over the last three decades, aquaculture production levels quadrupled from 1990 to 2020; furthermore, aquaculture represents around 50% of current world production of fish for direct human consumption, while also making a significant contribution to production of crustaceans, mollusks, and plants (FAO, 2022).

Despite its undeniable contribution to the production of food, the creation of employment, and in general, the development of countries, aquaculture can produce negative impact when it is not developed sustainably. In this regard, the main form of impact lies in the adverse footprint of effluents on ecosystems, in turn causing self-destructive effects for the activity itself, since (in addition to generating negative perceptions among society and the relevant government), the consequences, such as poor water quality and the spread of diseases, end up devastating production and profitability (Cao et al., 2007; Martínez-Córdova et al., 2009; Martinez-Porchas and Martinez-Cordova, 2012).

A significant advance toward sustainability in aquaculture could involve the integration of more than one species in production systems. In this sense, integrated multitrophic aquaculture is one of the most promising alternatives, as it concatenates the production of two or more species belonging to different trophic levels, all framed in the concept of the circular economy, making energy use more efficient and minimizing environmental impact (Knowler et al., 2020; Martinez-Cordova et al., 2022). Some of the most representative types of integrated multitrophic aquaculture include polyculture (Martínez-Porchas et al., 2010), biofloc technology (systems based on microbial bioaugmentation as edible biomass) (Emerenciano et al., 2017), aquaponics (König et al., 2018), and recently, the integration of biofloc technology with soilless plant production, also known as FLOCponics (Pinho et al., 2021).

Advances and Perspectives in Integrated Multi-Trophic Aquaculture is a Research Topic published in Frontiers in Marine Science that aims to present relevant and recent information on diverse aspects of the integration of multitrophic structures in aquaculture.

One of the areas included in the Research Topic relates to treatments for diseases and other problems that can affect the plants or animals farmed in hydroponics systems. The article "*Potential use of entomopathogenic and mycoparasitic fungi against powdery mildew in aquaponics*" by Folorunso et al. is an investigation of the efficacy of *Lecanicillium attenuatum* (LLA), *Isaria fumosorosea* (IFR), and mycoparasitic fungus *Trichoderma virens* (TVI) against *Podosphaera xanthii*, as well as the possible harmful effects of these three fungal biocontrol agents in aquaponics.

Similarly, the article "*Botanical and microbial insecticides application in aquaponics - is there a risk for biofilter bacteria and fish?*" by Raskovic et al. investigates the effects of three commercial insecticides, based on the active ingredients pyrethrum, azadirachtin, and spinosad, on aquaponics systems and their potential harmful effects on the fish farmed in the system and on the humans who consume them.

Some of the original research included in the Research Topic evaluates the potential of diverse species of crustaceans and fish as candidates to be farmed in integrated aquaculture systems. This is the case in the article "*Integrated multitrophic culture of shrimp Litopenaeus vannamei and tilapia Oreochromis niloticus in biofloc system: A pilot scale study*" by Holanda et al.. The authors demonstrate the feasibility of integrated shrimp and tilapia culture on a pilot scale without compromising shrimp productivity.

In the same way, in their article "*Life history traits for Ophryotrocha craigsmithi* (Wiklund, Glover and Dahlgren, 2009), *a candidate species in integrated multitrophic aquaculture*," Svensson et al. analyze the potential of this polychaete for inclusion in an integrated aquaculture system and found promising results in this regard.

Finally, Papageorgiou et al. present the article "*Can IMTA provide added ecosystem value services in the fish farms of Greece?*"; here, the authors find that an integrated multitrophic system reduces the adverse effects of a fish farm on the marine environment, in relation to both the water column and the sediment.

All these contributions help us to understand many issues involved in diverse integrated aquaculture systems and to advance toward sustainability; however, the use of integrated multi-trophic systems is still not common in the industry, so greater efforts are required to disseminate information on the potential benefits. We therefore conclude that multitrophic systems will continue to develop according to the needs of all the parties involved (environment, producers, society) in such a way as to conform, to an increasing extent, to the concept of the circular economy.

Author contributions

MM-P, FV-A, EG-V, and LM-C, contributed in the same way in the design of the Research Topic, invitation of authors, edition of manuscripts, and editorial monitoring of each document. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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