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Review Article

A review of types of feeds used in polychaete culture

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Abstract

Polychaete serves as aquafeed for most aquaculture species and as bioremediation agent of organic waste. Polychaete used for broodstocks of finfish and crustaceans stimulates gonadal maturation and endocrine system in penaeid shrimp, therefore overcoming the shortfall in juvenile production of animals and securing reliable production of aquaculture harvests. Commercial feed has gained the most ground in polychaete farming. Microalgae's essential nutrients and favorable morphology are ideal for polychaete larviculture. Home-made feed is less attractive due to its complex structural fibre but applicable as co-feed in polychaete nourishment. High organic matter waste is competitive as polychaete feed although it might lack adequate nutrients. The ideal feeds for polychaete growth, distinguished by the different life stages, are poorly studied. This review studies the fitness of microalgae in larviculture, nutritional value of commercial feed, and home-made feed as co-feed option, in polychaete nourishment; and the bioremediation benefit from polychaete's waste-feeding behaviour.

Keywords: polychaete, aquafeed, commercial fish feed, microalgae, organic waste

1. Introduction

Major discoveries on polychaete value have been made since the early 1990s. The early discovery on its value as fresh bait in sport and commercial fishing (Cole, Chick & Hutchings, 2018) stimulated further polychaete studies as aquafeed in the aquaculture industry (Costa, Passos & Fonseca, 2003). Polychaete feed for broodstocks of finfish and crustacean cultures can overcome shortfalls in the production of juveniles (Olive, 1999), as its neutral lipids and long-chain polyunsaturated fatty acids (PUFA) stimulate gonadal maturation (Lytle, Lytle & Ogle, 1990) and the endocrine system in penaeid shrimp (Meunpol, Duangjai, Yoonpun & Piyatiratitivorakul, 2010).

Polychaete demand by the aquaculture industry has led to the emergence of alternatives for sustaining polychaete stock (Pombo *et al*., 2018). Early polychaete farming started in Europe, beginning in the United Kingdom and the Netherlands, and then continuously developed worldwide (Costa *et al*., 2003). Culture methods such as intensive and semi-intensive culture have been implemented globally. In Asia, the early integrated aquaculture systems were largely implemented to effectively produce biomass with improved environmental effects (Folke *et al*., 1998). However, polychaete studies in Malaysia were mainly focused on the distribution and identification of polychaete species (e.g. Darif *et al*., 2016; Idris & Arshad, 2013; Polgar, Nisi, Idris, & Glasby, 2015) neglecting their diet.

Their benefits to penaeid shrimps' maturation encourage broader use of polychaete in aquaculture; either in live and pure form, or combined with other natural feed possibly in a formulated diet. Due to concerns of pathogenic disease transmission from wild polychaete to healthy broodstock (Mandario, 2018), collection from the wild has been avoided for aquaculture uses (Velvizhi *et al*., 2013). Therefore, increasing polychaete demand has contributed to the evolution of intensive polychaete cultures that can sustain supply for hatcheries and larval rearing units of finfishes and crustaceans. Thus, the polychaete culture in turn has stimulated the study of polychaete food preferences (e.g. Kim *et al*., 2017; Tsuchiya & Kurihara, 1979).

Aquaculture feed is responsible for health and quality of the cultured animals, sustaining the availability of fresh stock of the cultured product to match local and

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international demand, contributing to the economy of the country. To achieve an economical production of healthy and high-quality product, a good nutritional diet for the reared animal is crucial (Craig & Helfrich, 2017). The components in feed should be controlled and verified as safe for consumption, as this plays an important role in ensuring the quality of the end products.

A high-quality feed comprises important components that satisfy the nutrient requirements of the targeted animal and enables optimal growth at the various developmental stages of the cultured species. For planktotrophic larval species such as *Marphysa sanguinea* and *Platynereis dumerilii*, their nectochaeta larvae require high-quality feed to ensure survival and development to adult phase (Garcia-Alonso, Smith, & Rainbow, 2013; Kim *et al.,* 2017). For species such as *Sabellid spectabilis* and *Nereis diversicolor*, their lecithotrophic larvae preserve their own food; thus, feed is not essential during their larval stage (Bybee, Brock & Tamaru, 2006b). This highlights the importance of choosing suitable feed that can promote the best survival and growth rate in order to ensure effective production of the polychaete.

To our knowledge, this is the first review on the feeds used in polychaete cultures. In this review, we identify the different types of feeds used in polychaete cultures, discuss the nutrient compositions of these feeds, identify gaps that need to be addressed in future research on polychaete feeds, and recommend future research on this area.

2. Microalgae

For decades, microalgal feed has been common in hatchery production of many commercially important aquaculture species, as this is an essential food source for early developmental stages of species (Shields & Lupatsch, 2012). Polyunsaturated fatty acids (PUFA) such as eicosapentanoic acid (EPA), arachidonic acid (AA) and docosahexaenoic acid (DHA) are examples of important PUFA that can be found in microalgae (Guedes & Malcata, 2012). *Isochrysis* sp., *Tetraselmis* sp., *Chaetoceros* sp., *Thalassiosira* sp., *Nannochloropsis* sp., *Pavlova* sp. and *Skeletonema* sp. are commonly cultivated genera of microalgae (Enright, Newkirk, Craigie, & Castell, 1986; Thompson, Guo, & Harrison, 1993).

A preliminary study by Rouse and Pleijil (2001) reported that the numerous polychaete families vary in morphological and life cycle traits. Different polychaete development can be linked to different brooding modes; direct, lecithotrophic and planktotrophic (Giangrande, 1997). Planktotrophic and lecithotrophic traits are common in pelagic larvae. Planktotrophic larvae undergo the immature, free-swimming trochophore stage, in which it filter-feeds on smaller-sized food such as phytoplankton, diatoms and dinoflagellates. The feeding mechanism for capitellid larvae shows filter-feeding behavior, generally capable of retaining and ingesting particles of 2-20µm size (Nielsen, 1987; Strathman, 1987). *Mediomastus fragile* larvae digest particles in size spectrum from 2 to 10µm, with an optimal size of 7µm (Hansen, 1993). Daro and Polk (1973) reported that *Polydora ciliate* larvae graze on particles in the range ≤20µm.

Table 1 shows some studies on using microalgae as feed in polychaete culture.

The microalga species vary in size, environmental requirements, growth rate and nutritional value. For instance, Muller-Feuga *et al*. (2003) reported that *Isochrysis galbana* is widely used including as feed to polychaete larvae (e.g. Mok, Thiyagarajan & Qian, 2008; Leung & Cheung, 2017). Studies on polychaete species with planktotrophic larvae such as *Mediomastus fragile, Platynereis dumerilii* and *Hydroides elegans* shows the application of *Isochrysis galbana* to feed

Table 1. A summary of selected studies using microalgae to feed polychaete

Authors	Microalgae	Species	Study	Result
Shumway *et al*. (1988)	*Isochrysis galbana* *Isochrysis* sp *Tetraselmis levis* *Thalassiosira pseudomona* *Chromonas salina*	*Myxicola infundibulum*	Diet	*Tetraselmis levis* is most preferred.
Nielsen *et al*. (1995)	*Rhodomonas* sp	*Nereis diversicolor* *Nereis virens*		*Rhodomonas sp*. fed to *N. diversicolor* shows strong relation between ingestion rate and GR.
Leung & Cheung (2017)	*Isochrysis galbana* *Dunaliella tertiolecta* *Chaetoceros gracilis* *Thalassiosira pseudonana*	*Hydroides elegans*		*H. elegans* unable to consume *T. pseudonana* due to indigestible silicon wall.
Prevedelli & Vandini (1997)	*Ulva rigida*	*Perineries rullieri*	Larval	Alga enrichment in diet does not significantly affect SR or GR.
Hutchinson *et al*. (1995)	*Isochrysis galbana*	*Platynereis dumerilii*		*Isochrysis galbana* results in rapid GR and sexually-matured after 16 weeks.
Mok *et al*. (2008)	*Isochrysis galbana* *Dunaliella tertiolecta* *Chaetoceros gracilis*	*Pseudopolydora vexillosa*		*C. gracilis* and *D. tertiolecta* assist approximately 70% metamorphosis during 10 days of study.
Lavajoo (2019)	*Tetraselmis chuii* *Chaetoceros calcitrans* *Chlorella vulgaris* *Nannochloropsis oculata*	*Spirobranchus krausii*		*C. vulgaris* and *N. oculata* feed promote best growth due to smaller size and its immobility. Larvae at day 7 start to consume cells bigger than 7µm (*T. chuii* and *C. calcitrans*)

GR = growth rate, SR = survival rate

larvae up until metamorphosis (Hansen, 1993; Hutchinson, Jha & Dixon, 1995; Xie, Wong, Qian & Qiu, 2005). The use of *Isochrysis* sp. as feed to larvae offers potential as DHA source and assists the larvae's nutrient assimilation via their small size and absence of distinct cell wall (Sukenik & Wahnon, 1991). Helm, Bourne and Lovatelli (2004) reported that *Isochrysis galbana* have smaller cell volume and higher lipid content compared to *Tetraselmis suecica* and *Dunaliella tertiolecta,* making it convenient as larviculture feed.

The nutritional values of microalgae have been widely studied. Besides offering phytonutrients to the culture animals (Nichols, 2003), microalgae enhance growth and metamorphosis of many larval species (Becker, 2004). However, a few drawbacks may occur if several factors are neglected. The selected microalgae should be able to serve different needs throughout the production cycle with respect to size, digestibility and nutritional value (Muller-Feuga *et al*., 2003). Leung and Cheung (2017) found that *Thalassiosira pseudonana* is less preferred by *Hydroides elegans* larvae due to its tough silicon wall. Poorly digested *T. pseudonana* caused an abnormal swell of the larvae's gut as it passes through the gut without being processed in the stomach. Therefore, consuming unfitting microalgae may disrupt the larvae's nutrient uptake (Mok *et al*., 2008) and affect swimming activity in the culture (Hansen, Hansen & Nielsen, 1991).

Some commercially-produced microalgae species such as *Chlorella* sp., *Spirulina* sp. and *Dunaliella* sp. can be grown in open-air cultures and remain uncontaminated as they mature (Belay, 1997; Soong, 1980), while other species requires closed systems to avoid contamination (Borowitzka, 1999). Cultivation and management of microalgae for live feeds in hatcheries can also be costly as suboptimal conditions need to be maintained at all times to ensure high-quality microalgae production. Bacteria proliferation in the culture is possible especially when the microalgae die and rupture after reaching the senescent phase (Creswell, 2010). Therefore, it is best to avoid feeding stationary-phase microalgae in order to avoid bacterial proliferation issues.

2. Processed Feed in Aquaculture

Another famous polychaete culture feed is commercial fish feed, in the form of fish flakes, dry food and powder (e.g. Garcia-Alonso *et al.,* 2013; Prevedelli & Vandini, 1997; Serebiah, 2015). Global aquaculture sector has been dependent on the fish meal and fish oil in commercial fish feed for decades and the demand of these feeds is increasing. New and Wijkström (2002) suggested that estimates of fishmeal and fish oil demand are underestimates as aquaculture still expands rapidly. This dramatic increase has led to continuous efforts in fish feed advancement, to improve the feed so they can promote better results for aquaculture animals (Craig & Helfrich, 2007). Common fish feed contains fishmeal with high-quality protein, has a high energy content and essential minerals such as phosphorus, vitamins B, and essential fatty acids. Fish oil contains highly digestible fish lipids that provide PUFA in both omega-3 and omega-6 families of fatty acids, which are necessary for larval development of nervous system and assist immune system against disease agents (Miles & Chapman, 2006). Table 2 shows comparison on the nutrient contents of standard commercial feed and the green alga (*Ulva rigida*) obtained from Prevedelli and Vandini (1997).

Predominance of proteins in aquaculture feed aids in muscle development, growth and cell enzymatic activity. Study by Nesto, Simonini, Prevedelli & Ros (2012) shows that the higher protein content in the commercial feed influenced growth rate of *Nereis diversicolor* as well as speeded up the gametogenesis and sexual maturity of polychaete and also promoted fecundity of *Dinophilus gyrociliatus* and *Ophryotrocha labronica* (Prevedelli & Vandini, 1998; 1999). A limited study on commercial shrimp feed and commercial worm feed as polychaete diet was also found. Study on the effects of different diets on larval stage of *Marphysa sanguinea* by Kim *et al*. (2017) shows that a higher quantity of extruded pellets supplied to the polychaete resulted in a higher growth rate of the species in the first 20 days. However, further study is required to determine the effectiveness of shrimp feed to survival and growth rate of polychaetes.

The polychaete culture study (Serebiah, 2015) and nitrogen budget study (Honda & Kikuchi, 2002) involved the application of commercial worm diets in polychaete feeding. Serebiah (2015) addressed the use of worm feed in the form of concentrated liquid invertebrate food for the marine polychaetes, but it encouraged excessive bacterial growth in the culture and affected the survival of polychaete. Therefore, the suitability of worm feed for polychaete culture appears dubious.

Manufactured commercial feeds, either extruded (floating) or pressure-pelleted (sinking feeds), should be selected carefully depending on the feeding ecology of polychaete. Errant polychaete possesses free-swimming behavior and obtains food on the surface and within water column but sedentary polychaete remains stationary and filter feeds at the bottom of water column, on or in the sediment (Pardo, 2004). Few limitations of commercial feeds have been identified where not all manufactured feed forms are suitable for all polychaete, and these are usually expensive reflecting the manufacturing costs. Advancement of aquaculture has led to the development of species-specific diet formulations (Craig & Helfrich, 2017). However, there is a lack of studies on species-specific diets formulated for polychaete, while various other species-specific commercial feeds have been tested in polychaete studies (e.g. Brown, Eddy & Plaud, 2011; Kim *et al*., 2017; Nesto *et al*., 2012).

Table 2. Comparison of compositions between standard commercial feed (Tetramin) and a green alga (*Ulva rigida*) (Prevedelli & Vandini, 1997)

Component	Tetramin	*Ulva rigida*
Nitrogen (%)	7.88	4.60
Carbon (%)	44.65	32.23
Proteins (g %)	49.30	28.80
Lipids (g %)	11.50	3.73
Carbohydrates (g %)	n.d.	6.06
Vitamin C (mg/100g)	4.73	3.40
Vitamin E (mg/100g)	9.80	20.90
Calorie (kcal/100g)	340.00	232.00

3. Home-made Polychaete Meal

Previous studies show that human food and vegetables such as mixed cereals and spinach are possible as co-feed options for polychaete culture, providing nourishment for growth and enabling the polychaete to reach the epitoky stage and reproduce. Spinach finely chopped, frozen, soaked in seawater, or mixed with microalgae provides an alternative diet component for the polychaete (Garcia-Alonso *et al,* 2013; Hutchinson *et al*., 1995). A study by Akesson (1970) found that frozen spinach increases the growth rate and time span from hatching to the spawning of *Ophryotrocha labonica* compared to powdered algae and powdered spinach. Additional study by Garcia-Alonso *et al*. (2013) shows the frozen spinach as co-feed, along with live phytoplankton (*Tetraselmis suecica*) and fish flakes in *Platynereis dumerilii* culture as sufficient for the polychaete to reach the epitoky stage and reproduce. Selected polychaete culture studies on the use of processed feed are summarized in Table 3.

However, limited evidence was found on the usage of spinach and other plant concentrates as they can be ineffective as sole feed for polychaete. Plant-based nutrition studies by Miles and Chapman (2006) have found that plant-based protein is indigestible for animals due to its differences in cellulose and oligosaccharides that may result in depressed growth rate and feed intake. Nutritional inhibitors that interfere with nutrient digestion and metabolism of the animal may also be present in plants. Cereals are not the best option for polychaete feed because while they contain approximately similar carbon level as commercial feed, they lack in nitrogen and in complete amino acid profiles (Miles & Chapman, 2006).

4. Organic Waste

Along with the advancement of aquaculture, concerns of the impacts of aquaculture practices also rise. Aquaculture waste can cause accumulation of untreated by-products, residual food, and fecal matter, causing water quality deterioration and disease outbreaks in the culture system (Aguado-Giménez *et al*., 2007; Mallet, Carver & Landry, 2006). Apart from triggering health hazard by introducing aquaculture diseases to reared species, pathogen load in the culture system could cause major human health issues through culture product consumption (Gifford *et al*., 2004).

In a natural environment, polychaete aids sediment ingestion, reworking and burrowing so as to enhance organic matter mineralization and to sustain the benthic environment (Papaspyrou, Kristensen, & Christensen, 2007). This nutrient cycling behaviour contributes to the discoveries of polychaetes' potential as a bioremediation agent. Polychaete can increase bioremediation in aquaculture system as they convert organic matter from waste into their nutrients, and their burrowing action creates an oxidized layer in the sediment that provides an optimal environment for aerobic bacteria to proliferate (Kunihiro *et al*., 2005; Mandario, 2018), thus hastening organic matter decomposition in fish farms (Heilskov, Alperin & Holmer, 2006).

Deposit-feeding polychaete such as *Neanthes japonica* prefer to feed on the bacteria growing on the deposit surface rather than on fresh material (Tsuchiya & Kurihara, 1979). The faeces of *Neanthes japonica* act as the substrate for decomposing bacteria and microalgae, which allows faecal matter decomposition and also promotes detritus formation on the sediment surface, thus providing a food source for *Neanthes japonica*. Other species that feed on microbes include *Sabella spallanzanii*, *Capitella* sp. and *Ophryotrocha craigsmithi* (Fauchald & Jumars, 1979; Findlay & Tenore, 1982; Salvo, Dufour, Hamoutene & Parrish, 2015; Stabili *et al*., 2010).

Table 3. A summary of selected studies using processed feed for polychaete

Authors	Feed type	Species	Study	Result
Brown *et al.* (2011)	Uneaten halibut pellet Commercial worm diet	*Nereis virens*	Waste recycling	Uneaten pellet resulted in highest biomass and weight.
Marsh *et al.* (1989)	Fish flake (Tetramin Veggie)	*Capitella* sp	Diet	TetraMin and diatom show highest GR at nitrogen ration:biomass
Prevedelli & Vandini (1998)	Dry food (Tetramin)	*Dinophilus gyrociliatus*		Tetramin resulted in higher fecundity compared to spinach and cereal.
Nesto *et al*. (2012)	Classic C22 Hendrix Larviva BioMar	*Nereis diversicolor*		Higher protein in commercial feed showed higher GR than lower protein feed.
Kim *et al.* (2017)	Extruded shrimp pellet Chlorella powder	*Marphysa sanguinea*		Decapsulated artemia and extruded shrimp pellet showed highest SR and GR for the first 20 days.
Marsh *et al.* (1989)	Gerber's mixed cereal	*Capitella* sp.		TetraMin and diatom are better feed compared to Gerber's mixed cereal due to lacking of nitrogen levels.
Akesson (1970)	Frozen Spinach Powdered Spinach	*Ophryotrocha labronica*		Frozen spinach promotes highest GR and time span from hatching to spawning compared to green algae and *Nitszchia sp*. However, powdered algae promote higher GR and time span than powdered spinach.
Serebiah (2015)	Concentrated liquid invertebrate feed	*Nereis* sp.	Culture	Liquid invertebrate food and dried rotifers may cause excessive bacterial growth and poor survival of polychaete.
Garcia-Alonso *et al.* (2013)	Frozen Spinach	*Platynereis dumerilii*		Fish flakes and microalgae helps in worm GR and enables them to reach epitoky and reproduce.

Previous studies have reported successful *N. diversicolor* cultivation for the removal of organic load in the aquaculture water by using integrated multi-trophic aquaculture (IMTA) system with diets of *Huso huso* (great sturgeon) waste water, fish feed waste, smolt waste sludge and biogas residue (Berntsen, 2018; Pajand, Soltani, Bahmani, & Kamali, 2017; 2020; Seekamp, 2017). The IMTA system in Nederlof *et al*. (2020) consisted of the cultured animal (salmon) coupled with extractive species cultures (*Capitella* sp. and *Ophryotrocha craigsmithi*) that feed on waste (fresh, oven-dried, or acidified salmon faeces) showing that these polychaete species are efficient in waste conversion, as a reduced daily organic waste flux was deposited from this system compared to an average salmon farm.

Carbon (C), nitrogen (N), amino acids, crude protein, crude lipid, and crude fibre are commonly found in smolt waste sludge, along with biogas residue (Berntsen, 2018; Mandario, 2020). The nutritional content of organic waste varies, depending on the source and on environmental factors. However, waste with a low level of organic matter content cannot promote growth and survival due to deficiency in essential nutrients. Berntsen (2018) found that polychaete fed with halibut pellet showed more growth compared to smolt sludge and biogas residue diet. The growth of *Perinereis nuntia* fed with flounder faeces was lower than with commercial feed (Honda & Kikuchi, 2002) as confirmed also by Brown *et al*. (2011). Preservation of solid waste potentially affects its nutritional value due to compositional changes (Özyurt *et al*., 2016). Thus, this has constantly resulted in lower growth and bioremediation potential of polychaete compared to fresh waste (Nederlof *et al*., 2020).

The use of waste-fed polychaete as culture feed raises concerns of potential bioaccumulation of heavy metals and pathogens, such as *Escherichia coli* and *enterococci*, viruses, or protozoa from the waste sludge (Elissen *et al*., 2010). Polychaete grown on municipal wastewater sludges as aquafeed are discouraged as they could contaminate the food chain leading to human consumption. Nevertheless, the polychaete remain consumable for non-food animals such as aquarium fishes, ornamental aquatic animals (Drewes, 2005; Mount *et al*., 2006) and other non-food uses such as in fertilizers (e.g. Malaouki *et al*., 2009).

Table 4 summarizes selected studies on organic waste as feed to polychaetes.

5. Future Research on Polychaete Feeds

The feed effectiveness is crucial in ensuring the best quality and quantity of polychaete products for live feed in aquaculture. Culturing microalgae can be troublesome because culture maintenance is costly and delicate due to vulnerability to contamination and bacterial proliferation. Therefore, further studies on cost-effective method of microalgae rearing should be done. Furthermore, the feed suitability for polychaete by life stages – from the larval to the juvenile stage, and to the adult phase – should be further studied as the different life stages of polychaete require different types of feed and nutrients. Thus, this knowledge can allow meeting the polychaete's specific nutritional requirements according to the life stage. Besides, formulation of species-specific feed for polychaete that can fit the feeding ecology and requirements of the targeted polychaete species should be extensively studied to maximise the productivity of polychaete in the future. Although polychaete are an excellent bioremediation and extraction agent, the studies on waste-fed polychaete for the food chain of cultured animals consumed by humans are still very scarce. This knowledge can confirm the potential of these polychaetes as live feed and also could reduce the feed production costs as the culture animals and polychaete can be co-cultured in the same system.

6. Conclusions and Recommendations

Microalga *Isochrysis galbana* is encouraged for larval feeding, while commercial feed such as fish feed speeds up gametogenesis and sexual maturity of the polychaete. Meanwhile, spinach and other plant concentrates are ineffective as polychaete's main feed due to cellulose content that may result in depressed growth rate. However, plant feeds are compatible as co-feed in polychaete culture providing

Table 4. A summary of selected studies on organic waste as feed for polychaete

Authors	Waste type	Species	Study	Result
Tsuchiya & Kurihara (1979)	Deposits on intertidal surface	*Neanthes japonica*	Diet	Higher consumption of decomposed materials compared to fresh material.
Mandario (2020)	Bio floc Feed mill sweeping	*Marphysa iloiloensis*	Waste recycling	Bio floc and feed mill sweeping can increase biomass
Honda & Kikuchi (2002)	Flounder fecal waste	*Perineries nuntia*		Faeces shows lower GR than commercial feed.
Giangrande *et al.* (2005)	Aquaculture waste	*Sabella spallanzanii*		Biomass increases along with the waste removal.
Brown *et al.* (2011)	Halibut fecal waste	*Nereis virens*		Fecal waste shows highest total fat but does not influence biomas and weight.
Seekamp (2017)	Dried fish waste sludge Post-smolt waste sludge	*Nereis diversicolor*		Polychaete feed with fish feed, smolt waste sludge and shellfish diet have similar nutrient content.
Pajand *et al.* (2017)	*Huso huso* fecal waste			Biomas increased 5x compared to initial polychaete biomass.
Berntsen (2018)	Smolt sludge Biogas residue			Fish feed promotes highest GR.
Pajand *et al.* (2020)	*Huso huso* fecal waste			Higher density of sturgeon produces more waste thus promotes higher biomass and weight.

nourishment for polychaete's epitoky. Organic waste might lack adequate nutrients and waste-fed polychaetes are inappropriate for use as live feed to a culture due to biosecurity issues and potential contamination of the food chain. However, waste-fed polychaetes are suitable as bioremediation and extraction agents, as their nutrient cycling behaviour helps in organic loading clearing and also in replenishing the water quality in the culture system. For future studies, this review concludes that commercial feed such as fish feed is the best option for polychaete feed and shows positive effects on polychaetes' growth rate and productivity, as it offers complete nutrition for muscle development and cell enzymatic activities. Instead, microalgae such as *Isochrysis galbana* are convenient as feed to polychaete larvae as they are DHA sources with favourable morphological characteristics that facilitate nutrient assimilation. Home-made feed displays positive results as co-feed in polychaete nourishment. Polychaete in an integrated culture system help in the conversion of organic wastes into their food sources, thus speeding up the degradation rate of the waste.

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