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Production of Daphnia for Freshwater Nursery Rearing of Cultivable Fishes

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Abstract

Aquaculture producing the cheapest protein and good source of nutritional food for the human nutrition. However, intensification of aquaculture systems requires supply of high quality seed which indirectly influenced by the supply of live feed. Mass production and supplementation of live feed play a vital role in larval nutrition of aquaculture hatchery practices. The newly hatched larvae are highly relying on live feed which provides nutrients for growth and physiological activities. The Cladoceran like Moina and Daphnia spp. etc. have good source of nutritional food for many cultivable fishes. Daphnia is an inevitable live feed used in freshwater aquaculture. The impotence of commercial feed at early larval culture makes daphnia as potent live feed in many freshwater fish hatcheries. Therefore, the insemination of daphnia culture and their nutritional make up could help the hatchery people to perform well in the near future.

Introduction

Like humans, nutrition plays an important role in every creature of this world. Among the aquatic animals, the largest animal – Antartic blue whale - to the smallest tiny creatures visible to the human eye- Myxozoa – ingest feed to fulfil their nutritional requirement. The sustenance of life is maintained by the uptake of food which provides nutrients for the growth and other physiological activities. However, the nutrients requirement of every organism varies according to their feeding habit, life stage, environment, etc. Therefore, most of animals feeding habits changes once they grow from young-one to adult. In nature, most of the wild animals depend on nature's feed to satisfy their nutritional requirements. When it comes to domestication, like aquaculture practices, the captive animals completely rely on what we provide, to satisfy their nutritional requirements. At any point, wild or captive fish, they prefer natural feed – live feed – over the commercial diet because of their evolutionary behaviour. Therefore, still, in aquaculture live feed is playing a pivotal role in increasing the survival and production.

Mostly, the younger form of fish – larva, hatchlings, fry, and advanced fry – requires live feed than the adult fish. In general, young ones of many fish consume mixture of algae, cladocerans, copepods, rotifers, debris and other organisms. Among them, cladocerans – a smaller version of crustacean – is the highly preferred group by the fresh water fish – Indian major carps, Chinese carps, tilapia, ornamental fish, etc. There are about 420 species of cladocerans have been found around the world, however, the most commonly cultured species for the feeding of early stage of finfishes and shellfishes is daphnia. It is found in the tropics to the arctic, especially in the smaller ponds to larger freshwater lakes. There are 50 species of Daphnia are reported worldwide, but out of only six of them

normally occur in tropical areas (Delbare and Dert, 1996).

Daphnia is an inevitable live feed used in freshwater aquaculture. Due to its general appearance and irregular behaviour, it is called by the name of water flea. It is a small crustacean which sizes around 0.2-3.0 mm long. *D. pulex* and *D. magna* are the two dominant species cultured and used for aquaculture practices. The impotence of commercial feed at early larval culture makes daphnia as potent live feed in many freshwater fish hatcheries. Therefore, the insemination of daphnia culture and their nutritional make up could help the hatchery people to perform well in the near future.

Identification of Daphnia:

- It has a large head with rostrum.
- Thorax and abdomen covered by the carapace.
- The abdomen which is bent down ward is free of appendages.
- In cephalic appendages, second maxilla is absent.
- Paired eyes are fused into one.
- Five pairs of leaf like feet present on thorax.

Reproduction and Life Cycle of Daphnia

Being a cladocera, it has the capability to reproduce in both sexually and asexually. However, parthenogenesis reproduction is very common among cladocerans. In this, female produces a amictic eggs – a clutch of parthenogenetic eggs – and keep them in brood pouch. The developmental process takes place in brood pouch and after completion of development – in 3 days – the smaller young ones directly released from the mother brood pouch. The produced daphnia looks much similar to their mother – like a clone – but without a brood pouch. After six moltings, the young daphnia attain maturity and produce the egg for first time – primipare stage. In general, it takes 5-10 days to reach the primipare stage by the younger daphnia; however, the duration is highly temperature dependent. Once in 3-4 days interval, the adult daphnia releases the eggs which continue till her death. Life span of daphnia under captive conditions is about 2 months.

Importance Daphnia in Aquaculture

- Daphnia is a very good source of live feed in freshwater aquaculture industry.
- Daphnia can be easily enriched with different compounds through bio-enrichment process which improves the nutritional quality of live feed organism. The following materials can be enriched in daphnia using either by feeding or incorporating methods, Microdiets.
- Microencapsulated diets.
- Baker's yeast.
- Vitamins.
- Emulsified lipids rich in Highly Unsaturated Fatty Acid (HUFA) with vitamins.

Table 1: List of live feed and their size for bio-enrichment in aquaculture

Sl. No.	Live feed	Size (µm)
1	Microalgae	2 - 20
2	Rotifers	50 - 200
3	Artemia	200 - 400
4	Daphnia	200- 400
5	Moina	400 - 1000

Nutritional Composition of Daphnia

Daphnia, like other heterotrophic organisms, is fully depends on the chemical composition (nutrients) of their different feed sources. Most of the daphnia species inhabit in freshwater ecosystems, at a maximum of 5 ppt saline water, therefore, it is not a suitable live feed for brackish water and marine organisms. Additionally, rearing of daphnia in saline waters leads to lower accumulation of essential fatty acid in their bodies (Brett *et al.,* 2006). On the other side, daphnia has a good source of different digestive enzymes such as proteases, amylases, lipases and cellulase which helps in digestion of developing larvae, through the source of exoenzymes in the gut (Cheban *et al.,* 2017).

Table 2: Depicts nutritional composition of daphnia

Sl. No.	Biochemical parameters	% of composition
1	Protein	45-70 %
2	Lipid	11-27 %
3	Carbohydrate	15-20 %
4	Moisture	85-95 %

Methods of Daphnia Culture

Batch Culture

It is a type of continuous culture in which daphnia is constantly produced and harvested. In this method of culture, a series of tanks were used and in each tanks were fertilized at different intervals for algal production, which will be grazed by growing daphnia. After inoculating the culture tanks with pure culture of daphnia, the proliferating daphnia starts feeding algal cells, bacteria and other debris. Once the culture reaches 7th day, the daphnia need to be harvested and the tanks will be used for next batch. This kind of method is more suitable, where a continue demand exists for daphnia at a specified quantity for each day. It is also good for maintaining the pure culture as this method has least chance of contamination with their competitors and predators.

Semi-Continuous Cultures

It is a modified version of continuous culture system in which culture is maintained for a duration of 1-2 months or more by doing daily partial harvests of daphnia. This method requires little more maintenance than the continuous culture like regular feeding, water quality maintenance, stocking density monitoring and water exchange at weekly basis.

Tanks or Containers

In this method, different capacity tanks, minimum 50 l to maximum 500 l, and the containers were used to culture the daphnia. Volume off the tank is varies based on the requirement of yields. In general, concrete, plastic or fiberglass and earthen ponds were used to produce the daphnia at commercial level. Tanks which are made up of stainless steel do not require painting. The advantages of tank based culture is, it offers shallow water depth which allows good light penetration for algal production and provides a large surface area to volume ratio for better oxygen diffusion from atmosphere. A greenhouse shade net with 50-80 % light reduction yields better daphnia production. In the case of outdoor culture systems, culture tanks should be protected from rain, predator and aquatic insects.

Daphnia Culture in Pond

Like other systems, daphnia can be raised in earthen ponds using simple maintenance techniques. Ponds with minimum of 60 cm and maximum of 1.5 m height can be well utilized for daphnia production. A culture pond with 2500 m^3 of area could produce 1 ton of daphnia per week. With 5 cm height of sun dried soil, lime is added (dose – 0.2 kg/ 1000 kg of soil) and then the pond is water (up to 15 cm height). Followed by water filling, on 4^{th} day organic manure, poultry manure at 0.4 Kg/m^3, was added to promote the algal production. In general, it is recommended to use organic fertilizers rather than inorganic fertilizers for better production of daphnia in ponds. Once the culture is progresses, after 12 days, water level needs to be raised to 50 cm and fertilized second time with organic manure (poultry manure – 1 Kg/ m^3). Later, weekly fertilization with poultry manure at 4 Kg/ m^3 is recommended. Additionally, organic manure suspension prepared using fresh cow dung (10 g/l) is applied after filtration (100 µm sieve). The prepared suspension was applied @ 10 l day/ 1000 l in first week which was then increased in subsequent weeks (2^{nd} week – 20 l; 3^{rd} week – 30 l) based on the requirements. After the 15 days of fertilization, daphnia with 10 Nos./l is inoculated in the ponds.

Contamination in Daphnia Culture

Rotifers are the most common contaminant in daphnia culture tanks. In general, species like *Brachionus, Conochilus* and delloids are accidentally proliferate in daphnia culture tanks which later reduce the daphnia production by competing them with food and area. *Brachionus* species can be easily removed from the culture water using an appropriate mesh sized sieve, which allows rotifer to pass thorough sieve and retain the daphnia based on their size differentiation.

Figure 1: Indoor culture of daphnia

Figure 2: Outdoor culture of daphnia

Harvesting of Daphnia

Daphnia mostly swims in the surface of water which can be very easily harvested using 100-200 µm mesh size nets. In the case of semi-continuous daphnia culture, 15-30 % of the population is allowed to harvest in partial harvesting. The entire stock is harvested only during restarting of the culture. In draining and siphoning based harvesting times, it is recommended to do water exchange which improves the water quality. On occasions, where sufficient quantity of daphnia is not obtained from the culture tank, then the harvested animals are kept in a freshwater container, provided with oxygen facility, to keep them alive.

Table 2: Water quality parameters in daphnia culture

Sl. No.	Water quality parameter	Range
1	pH	6.5-8.5
2	Dissolved oxygen	2-5 mg/litre
3	Temperature	18-24 °C
4	Hardness	250 mg/litre
5	Potassium	<390 mg/litre
6	Magnesium	30-240 µg/litre
7	Ammonia	< 0.2 mg/litre
8	Light	10-20 hour photo-period

Conclusion

Daphnia is a very important cladoceran group crustacean and it is considered as healthy and highly nutritional diet in aquaculture. Smaller size of daphnia and their fast moving nature attract the fish larvae to hunt them. Additionally, the simple rearing techniques and smaller rearing unit making them as important live feed in freshwater hatcheries. Daphnia have huge amount of exoenzyme like proteinases, amylases, lipases and cellulase these are helpful in the digestion and growth of the developing fish larvae which exoenzymes are not that much available in the other live feed.

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