Eco-Friendly Aquaculture: First-Generation Organic Carps

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ABSTRACT

The demand for organically produced fish is becoming increasingly important, and consumers prefer other organic crops as a consensus on a healthy diet. To produce organic fish on a commercial scale, organically produced quality seeds are needed. However, uncertainty in the timeliness and quantity of seed supply is one of the major constraints in organic aquaculture. Therefore, a trial was undertaken for the production of organic carp seeds at the Natural Farming Unit, ICAR-CIFA, Bhubaneswar. During the monsoon season, fully matured male and female broods were selected from organic culture ponds. Females were injected with pituitary gland (PG) extract twice, but males were injected only once through the intraperitoneal route. The first dose was given in the evening hours to the female at 5-6 mg/kg body weight, and the second dose was given 4-6 hours after the first injection at 8-16 mg/kg body weight. Males were injected at the time of the second dose of 4-5 mg/kg body weight. Induced breeding was carried out by mixing two males per female from breeding hapas fixed in organic fish culture ponds. Spawning was performed in breeding hapa, but hatching was performed in circular incubation pools (cement). The spawn (first generation catla, rohu, and mrigal) produced were reared to the fry stage in a large concrete (50 m3) tank following the organic nursery rearing protocol. To enhance fertilization efficiency, liming was regularly performed in cement tanks. For the sustained production of natural fish food organisms in the rearing tanks, a mixture of mahua oil cake, raw organic cow dung, kalabati rice powder, yeast, jaggery, and organic rock phosphate was applied on a weekly basis, and spawn were also fed daily with a supplementary diet at a 1:1 ratio (kalabati rice powder:fish meal). At the end of 15 days, 50,000 rohu, 30,000 catla, and 20,000 mrigals of advanced fry were produced from large concrete (50 m^3) tanks. Our study revealed that by following the standard protocol for organic carp seed production, the seeds of three species of organic carp could be easily produced. This is an attempt to produce the organic carp seeds of rohu, catla and mrigal. For the production of organic fish ponds, fingerlings produced from the earthen organic ponds of the IMC were stocked at two different stocking densities (SDs) in triplicate in grow-out pond experiments (SDs: 4,000 no./ha and 8,000 no./ha). The experimental fish were fed pelleted feed prepared from locally available organic feed ingredients at 2% of their body weight. After 15 months of culture, we found that the weight gain of the fish at an SD of 4000/ha was significantly greater and the FCR was lower than that at an SD of 8000/ha.

Keywords: Organic fish, Pituitary glands, First generation, IMC, Spawn, Fry, Nursery rearing, Growth, Pelleted feed, etc.

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INTRODUCTION

Organic agriculture is "a production system that safeguards the health of soils, ecosystems, and people," according to IFOAM Organics International, the umbrella organization for the global organic industry. It focuses on biological cycles, processes, and biodiversity that are appropriate for the local environment rather than inputs that have detrimental effects. To improve the environment and promote relationships and a good standard of living for all participants, organic agriculture mixes tradition, creativity, and science (IFOAM, 2014). Historically, systems and products that use the term "organic" (or its translations into other languages, such as "biologique," "ecologico," etc.) have focused on the maintenance and health of soils as their foundation for production. The crops and cattle cultivated as primary products are derived from the earth, after which they can undergo further processing before being delivered to the final customer. Communities that live close to the land require healthy soil, particularly to maintain peaceful connections (Deguine et al., 2021). These are basically terrestrial, soil-based systems, and it is difficult to raise organic crops and livestock in a terrestrial setting without good soil management. The three pillars of ecological health, justice, and caring form the basis of organic systems: "The principles cover the care of soils, water, plants, and animals for the production, preparation, and distribution of food and other products in the fullest meaning of the word. They relate to how people interact with living environments, build relationships with one another, and leave a legacy for future generations (IFOAM, 2014). In contrast to agriculture, aquaculture frequently does not prioritize soil quality, which is otherwise essential. However, to produce some aquatic species, it is necessary to maintain the soil that is adjacent to or buried beneath an aquatic system that is located on land, such as a pond, river, or estuary. However, it is possible to apply organic principles to aquaculture systems, and there are strong arguments for doing so. Twenty percent of the animal protein consumed by the world's 3.3 billion people comes from aquaculture, which continues to play a significant role in human diets. India is the second-largest producer of aquaculture in the world behind China (FAO, 2020). The United Nations predicts that by 2050, there will be 9.7 billion people on the planet, up from 7.7 billion in 2019. In such circumstances, feeding a rising elite global population is a challenge to which organic farming offers a realistic answer. Many experts (Badgley et al., 2007; Scialabba, 2007; Reganold and Wachter, 2016; Muller et al., 2017) believe that organic agriculture can supply the world's food supply, but others disagree (Trewavas, 2001; Cassman, 2007; Connor, 2008, 2013). However, the methods used in aquaculture production can put a burden on natural aquatic ecosystems by reducing the amount of food available to wild populations or by polluting nearby regions with contaminated effluent. In contrast, the goal of the organic sector is to positively influence aquaculture production through the development of ecologically integrated systems that preserve the environment, maintain or increase biodiversity, increase animal welfare, and generate high-quality, healthy products.

MATERIALS AND METHODS

In the present study, an attempt was made to develop a protocol for the organic farming of Indian major carp. The study was conducted in six renovated earthen ponds of the ICAR-CIFA farm with no history of fish culture over the last 10 years. During 2020–2021, induced breeding and seed production of Catla,Rohu & Mrigal were achieved successfully using carp pituitary extracts. A trial was undertaken for the production of carp seeds organically at an Natural Farming Unit, ICAR-CIFA. The carp females were injected with the pituitary gland extract (PGE) twice, but the males were injected only once through the intraperitoneal route. The first dose was given in the evening hours to the female at 5-6 mg/kg body weight, and the second dose was given 4-6 hours after the first injection at 8-16 mg/kg body weight. Males were injected at the time of the second dose of 4-5 mg/kg body weight. Induced breeding was carried out by mixing two males per female from breeding hapas fixed in organic fish culture ponds. Spawning was performed in the breeding hapa, but hatching was performed in the incubation pools.The spawn produced for all the carp species were reared in a large concrete (50 m^2) tank following the organic culture protocol up to the fry stage. To enhance fertilization efficiency, liming was regularly performed in cement tanks. For sustained production of natural fish food organisms in the rearing tanks, a mixture of mahua oil cake, raw organic cow dung, kalabati rice powder, yeast, jaggery, and organic rock phosphate was applied weekly, and spawn was fed daily with a supplementary diet at a 1:1 ratio (kalabati rice powder: fish meal) (Tables 1&2). For the production of organic carp ponds, fingerlings (rohu, catla, and mrigal) produced from earthen organic ponds were stocked at two different stocking densities (SDs) in triplicate in grow-out ponds (SDs: 4,000 no./ha and 8,000 no./ha). The stocked fish were fed pelleted feed (28% protein, 6% lipid, and 3.5 kcal/g gross energy) prepared by using locally available organic feed ingredients (mahua oil cake, polanga oil cake/Indian doomba, *Calophyllum inophyllum*, wheat flour, organic rice, fish meal) at 2% of their body weight. The stocking ratio was maintained at 1:1:1 for rohu, catla, and mrigal.

Table 1. Chemical composition of the organic feed ingredients used (% dry matter) in pellet feed preparation

Ingredients	Crude Protein	Dry Matter	Ether Extract	Crude Fiber	Total Ash
Fish Meal	60.10	92.8	10	1.3	12.5
Mohua Oil Cake, (MOC)	24.12	92.5	9.4	8	7
Polanga Oil Cake (POC)	28.2	92.3	9.2	7.6	6.2
Wheat Flour (Organic)	10	92.2	1.1	0.8	1.32
Organic Rice along with husk	5	91.9	0.32	14	8

Organic inputs were procured by the Tribal Federation, Bhubaneswar, Odisha Ministry of Tribal Affairs, Govt. of India.

Table 2. The chemical composition of the organic pelleted feed included the following:

Crude Protein	Dry Matter	Ether Extract	Crude Fiber	Total Ash	Gross Energy (GE)
27.72%	92%	6.31%	7.6%	12.0%	3.53 Kcal/g

RESULTS AND DISCUSSION

In an aquaculture setting, a female fish received its first dose of a pituitary hormonal injection in the evening, amounting to 5-6 mg/kg of body weight. This injection likely contained hormones that trigger the maturation and release of eggs. Hormonal pituitary injections are commonly used to synchronize the breeding process in fish farming, ensuring that males and females are ready for reproduction at the same time. Approximately 4-6 hours later, the female fish received a second hormonal injection at a dosage of 8-16 mg/kg of body weight. This higher dosage may further stimulate the maturation of eggs and increase the chances of a successful breeding event. Males were introduced into the breeding process at the time of the second dose. They also received injections of 4-5 mg/kg body weight. This step ensures that the males are also hormonally primed for breeding and can release sperm when the females are ready to release their eggs (Fig. 1).

Fig. 1. Induced breeding & seed production of Indian Major Carps, IMC in hapas using carp pituitary extracts

The breeding process took place in specialized breeding hapas, which are enclosures in organic fish culture ponds. This controlled environment helps to prevent the escape of the fish and allows easy monitoring of the breeding process. Induced breeding was carried out by mixing two males per female from breeding hapas fixed in organic fish culture ponds. Spawning was performed in the breeding hapa, but hatching was performed in the incubation pools. The first-generation spawns of these three species were reared in a large concrete (50 m^3) tank with an organic protocol up to the fry stage (Fig. 2).

Fig. 2. Fertilized eggs and fry of Indian major carp at the Natural Farming Unit, CIFA

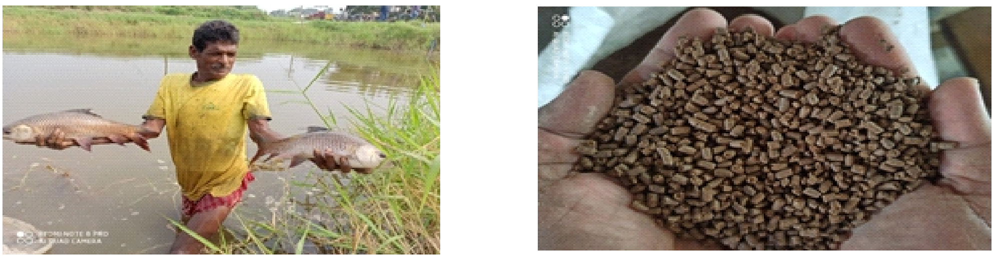

Fig. 3. The pelleted feed contained 27.72% crude protein, 92% dry matter, 6.31% ther extract, 7.6% crude fiber, 12.0% total ash, and 3.53 kcal/g gross energy(GE)

Fig. 4. Fingerling and table size grow-out organic fish production at Natural Farming Unit, CIFA

Additionally, the observed data suggest that optimizing stocking density can contribute to more efficient and sustainable organic fish farming. This balance is critical for maximizing economic returns while maintaining environmental sustainability and fish welfare. According to the National Program for Organic Production (NPOP), organic fish production should not exceed 2000 kg/ha. Our study, which assessed first-generation organic carps, yields ranging from 1197 kg/ha at a stocking density (SD) of 4,000 nos./ha to 1767 kg/ha at an SD of 8,000 nos./ha. These results comply with NPOP standards, ensuring that our organic production methods are within permissible limits. At the lower SD of 4,000 nos./ha, the production of 1197 kg/ha aligns well with sustainable practices, indicating the efficient use of resources and better fish growth and survival rates. This stocking density offers a balanced approach, promoting individual fish health and optimal feed conversion ratios (FCRs). The higher SD of 8,000 nos./ha, resulting in 1767 kg/ha, also meets the NPOP guidelines but shows reduced individual growth and increased FCR. Although total production is higher, there is increased competition for resources, leading to higher mortality and less efficient feed utilization. These findings highlight the importance of optimizing stocking densities to achieve sustainable and efficient organic fish farming. Maintaining production within NPOP limits ensures environmental sustainability and fish welfare, suggesting that SDs of approximately 4,000 nos./ha are preferable for balanced, sustainable organic aquaculture. Further research is needed to refine these practices for better long-term outcomes. Future research could focus on exploring intermediate stocking densities, varying feeding regimes, and the use of natural supplements to further refine these practices.

CONCLUSION

This study provides valuable insights into the impact of stocking density on the growth performance, survival rates, fish production, and feed conversion efficiency of first-generation organic carp. By understanding these dynamics, aquaculture practitioners can make informed decisions to optimize production systems for both economic and environmental sustainability.

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