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Importance of Proper Breeding Techniques in Enhancing Magur Seed Production

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Fish farmers in eastern India, consider it to be a species of choice for diversifying their cultural practice since it provides them with a considerable return on their investment. The natural seeds of Magur have been sharply declining due to ecological imbalance in their natural breeding ground, which is low lying paddy field. This imbalance is caused by the indiscriminate use of chemical fertilizer and chemical pesticides. However, the availability of Magur seeds in desired hours of stocking in desired quantity stands as a constraint to the propagation of culture of this species. It is consequently the only method that is feasible to reduce the severity of the issue, and that is to induce breeding of the species in captivity. There have only been a few models designed for the purpose of reproducing Magur in captivity, but each of these models involves a significant amount of financial investment. However, a labor-intensive and low-cost farmers'-friendly model for the

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production of small quantity seeds has not yet been standardized for rural small scale fish farmers. In this paper we found that magur seed production can be done through low cost investing, that's why farmers or rural people get more economic profit. The study demonstrates how specific breeding techniques and management practices can significantly enhance seed production, contributing to the sustainability of Magur aquaculture in India.

Keywords: Magur; fish farmers; seeds; India.

1. INTRODUCTION

In order to ensure that the breeding and seed development processes are successful, the manufacturing of Magur seeds requires a number of different procedures and components. There have been studies that have demonstrated that promoting breeding in Magur (*Clarias batrachus*) through the use of hormone stimulation like as WOVA-FH (synthetic hormone) and HCG (human Chorionic Gonadotropin) can result in fertilization rates ranging from 73.22% to 84.22% and hatching rates ranging from 78.53% to 86.79% (Jham et al. 2022). When it comes to seed production, weaning larvae from live feed to formulated feed throughout the process of larval rearing is of the utmost importance. The ideal weaning age for *C. magur* larvae is approximately 15 days after hatching, as this allows for excellent growth and survival rates (Mohammad et al. 2007). Additionally, it has been discovered that the utilization of Ovaprim hormone in FRP (fiberglass reinforced plastic) hatcheries is effective in induced breeding operations. This results in increased relative fecundity, body weight, ovulation percentage, and normal larvae percentage, which ultimately contributes to the production of high-quality Magur seeds (Baidyanath 2015). The necessity of optimal breeding techniques, weaning protocols, and hormone stimulation in the process of increasing Magur seed production is brought to light by these newly discovered facts (Bo 2016,Vignesh 2017).

Fish farming, or aquaculture, plays a crucial socioeconomic role in India, significantly impacting the livelihoods of rural communities. With abundant water resources and favourable climatic conditions, the region has immense potential for fish farming. This sector not only provides a reliable source of protein but also creates job opportunities and stimulates economic growth (Rccp et al. 2022). The practice of fish farming has become increasingly popular among local farmers as a means of supplementing their income (Masudul 2004, Khan et al. 2000, Rafiqual et al. 2018). Many families engage in aquaculture alongside traditional agriculture, allowing them to diversify their sources of livelihood. This dual approach helps mitigate risks associated with reliance on a single crop or income source, enhancing financial stability for households. Furthermore, fish farming requires relatively low initial investment and can be practiced in small ponds, making it accessible to a large number of rural residents. The economic benefits of fish farming extend beyond individual households. It contributes to the local economy by creating jobs in related sectors such as feed production, fish processing, and marketing (Mohapatra et al. 2018). As fish farming operations expand, demand for inputs like feed, equipment, and transportation services increases, generating further employment opportunities within the community. This economic ripple effect can lead to improved living standards and enhanced quality of life for many residents (Suko et al. 2015,Chattopadhyay et al. 2013, De andPandey 2014).

Furthermore, aquaculture offers a sustainable way to meet nutritional needs as the region's population grows and the demand for high-protein foods rises (Mohammad et al. 2022). By producing fish locally, communities can lessen their reliance on outside sources and ensure a steady supply of affordable and nutrient-dense food—a crucial aspect in North East India, where access to a variety of food sources can be limited.

Aquaculture practices can contribute to the conservation of native fish species. By promoting the cultivation of indigenous species like Magur and Koi, fish farming can help alleviate pressure on wild fish populations and protect biodiversity. Sustainable aquaculture practices, such as integrated fish farming, can enhance productivity while preserving the environment. For instance, combining fish farming with rice cultivation allows for effective nutrient recycling and optimal land use, benefiting both crops and fish. Education and capacity-building initiatives are essential to maximize the potential of fish farming in North East India. Training programs organized by agricultural universities and research institutions can equip farmers with the necessary skills and knowledge to adopt best practices in aquaculture. Topics such as breeding techniques, disease management, and sustainable farming practices are critical for ensuring the success and viability of fish farming operations. By empowering local farmers with information and resources, the sector can thrive, contributing to both economic development and food security. fish farming in North East India serves as a vital socioeconomic engine, providing income, employment, and food security for rural communities. The sector's potential for growth and sustainability is significant, especially when supported by education and capacity-building initiatives (Tamara et al. 2017) by harnessing the region's rich aquatic resources and promoting responsible aquaculture practices, North East India can secure its position as a leader in fish production while enhancing the livelihoods of its people.

Jham, Lal, Pravesh, Kumar, Sahil, Rai, P., Srivastava, Shivendra, Kumar, Roshan, Rammed, S., and C. Rai was included (Lisa andLowe 2022). This study examined how infusoria with HUFA (highly unsaturated fatty acids) and vitamin C affected C growth and survival. The organism has magur larvae. The Asian catfish C. magur was first described by Hamilton in 1822. The nutritional and medicinal properties of this fish makes it popular throughout Asia. Due to the high larval mortality rate, magur aquaculture is limited due to seed shortages. Measures to promote larvae survival during early development may increase this species' seed production. Thus, this study examined how infusoria treated with HUFA (highly unsaturated fatty acids) and vitamin affected growth and survival of C. magur larvae. Eight-day-old larvae, weighing three milligrams and measuring five millimeters, were placed in (30 x 20 x 18 cm) plastic crates with forty liters of water each. Each of sixteen boxes contained 100 larvae during the trial. The larvae were fed HUFA (highly unsaturated fatty acids), vitamin C, a combination of the two, and un-enriched infusoria at nine to ten numbers per milliliter of rearing water for 30 days. Four treatment groups did this. Based on proximate analysis of enriched and un-enriched infusoria, HUFA-enriched had the highest moisture (84.25%), crude protein (9.80%), crude lipid (3.50%), and ash content (0.78%). Highest percentage of all three components in vitamin C-enriched infusoria. The treatment group given HUFA-enriched infusoria had the highest survival rate (49.25%), while the control group had the lowest (18.25%). This shows that enriching infusoria with HUFA could increase survival. HUFA supplementation caused the biggest body weight rise (55.75 mg), but it did not differ from the control group. The investigation found that enriching infusoria with HUFA significantly improved larval survival.

The research region has deep alluvial soil, moderate rainfall, abundant sunlight, and several perennial rivers. It owns ponds, lakes, tanks, and irrigation projects. It has untapped water resources and excellent potential for inland fish production. Even then, it relied on Andhra Pradesh for half of its yearly fish supply(Baidyanath Kumar 2015, Raj et al. 2022). Fish is eaten by most people, hence the fishing industry is essential to the economy. Fish can provide protein, fat, inorganic chemicals, and vitamins. Fish protein is easily digested and high in soluble proteins. Due to its 74% ponds and 63% water spread area, North Bihar has the most potential. Each of the 21 research districts produces inland fish. The bulk of fisherman were Sahni.

2. MATERIALS

Induced breeding of *Clarias magur* was conducted using a pair of wild-caught mature fish, a male weighing 110 g and a female weighing 150 g, in July 2018 at Takipara village, Balagarh Block, Hooghly District, West Bengal, India (Lat. 23° 2' 31'' N and Long. 88° 26' 22'' E). This endeavor involved the local fishing community and adhered to the standardized protocol established by Mahapatra et al., which was previously applied to the breeding of the similar catfish species *Clarias batrachus*.

3. METHODS

3.1 Breeding Management

In small ponds (200-400 m2) or cement tanks, 100-200 g brooders are kept at 1-2 fish per m3. Captive brooders need high-quality water and nourishment to mature. Broodfish are raised in cement containers with 4-6 cm earth bases. To avoid rainy season collection issues in the pond, broodfish should be moved to cement tanks at least two months before breeding. Brooders are fed twice daily fish meal-based feed with 30-35 percent protein at 2-3% body weight. Brooder tanks should exchange 20-30% water fortnightly to preserve water quality.

3.2 Brooder Selection

Magur reaches sexual maturity at one year of age and reproduces during the monsoon season, which occurs from June to August. Broodfish weighing between 100 and 200 grams, and aged between 1 and 2 years, are thought to be the optimal size for induced breeding. Broodfish can be distinguished by their secondary sexual features. The male possesses an extended and pointed genital papilla located near the anus, while the female has a spherical and button-shaped genital papilla. Additionally, a fully matured female exhibits a bulging abdomen and a reddish vent, indicating her ready to spawn. The chosen brooders are segregated based on their sex and placed in indoor tanks with gentle aeration and showers to stimulate breeding (Sahoo et al. 2016,Das 2002).

3.3 Artificial Spawning

Effective artificial reproduction of magur necessitates the use of synthetic hormones. Typically, females are given a dose of GnRH-based hormone at a rate of 1.0-1.5 ml per kg of body weight. The females are subjected to hormone injection for 17 hours in order to induce ovulation and obtain eggs. Similarly, male brooders are given a hormonal dosage of 0.5 ml per kg of body weight.

A B

Fig. 1. Identification of Sex (A= Female, B= Male)

Fig. 2. Administration of an inducing hormone

4. RESULTS

4.1 Preparation of Sperm Suspension

As the male brooders do not react to stripping, they are sacrificed in order to collect their testes. The guy with testes of a creamy white color is chosen for the creation of sperm suspension. The sperm solution can be made by grinding the testis in a normal saline solution containing 0.9% Sodium chloride, resulting in a suspension of sperm. An optimal sex ratio for achieving increased fertilization is a ratio of 1:2, with one male for every two females.

4.2 Fertilization

Fertilization refers to the process of combining male and female reproductive cells, or gametes, to initiate the development of a new organism. The eggs are gathered in a plastic tray for the purpose of fertilization and are then fertilized using a suspension of sperm. Afterwards, the eggs are completely combined with the soft feather and a small amount of water is added to activate the sperm and ensure effective fertilization. After a period of 2-3 minutes of blending, the eggs are meticulously rinsed with mild tap water and transferred to the flow-through incubation tubs. The eggs of magur exhibit sticky properties, with light brown eggs being deemed viable and white eggs being regarded unfertilized.

4.3 Hatchery that Operates on a Flow-Through System

The flow-through hatchery is made up of a platform that is made of cement, and on that platform, plastic tubs that are 30 centimeters in diameter and 15 centimeters in height are arranged in a row beneath the water faucet. It is typical for the tubs to hold one thousand eggs. Every single plastic tub is equipped with a flow-through opening that allows water to escape. The eggs that have been fertilized are spread evenly throughout the incubation tubs, and a modest water flow is provided in order to keep the water quality in the best possible condition overall. At temperatures between 27 and 30 degrees Celsius, the hatching process takes approximately 24 to 27 hours. Following the hatching process, the larvae are obtained by washing the incubation tubs and then transported to tanks specifically designed for the raising of larvae. The newly hatched larvae have a length of around three to five millimeters and a weight of about two to three milligrams. They keep their yolk sac until three days after hatching (Sinha et al. 2014).

4.4 Incubation of Larvae

4.4.1 The management of water

Because larvae are so little and sensitive, they require high-quality water in order to have a better chance of growing and surviving. It is for this reason that the quality of the water used in indoor rearing systems is a significant factor in the generation of seeds. Due to the fact that the aerial respiration begins after ten to eleven days, the larval rearing tanks need to be equipped with aeration and a gentle water flow that is constant throughout the day in order to keep the water quality at the required level. It is normal for rearing tanks to experience difficulties such as the accumulation of metabolites and unused feed, both of which can cause the larvae to experience stress. To ensure that *Clarias batrachus* larvae and fry are raised to their full potential, it is recommended that water be exchanged at optimal water quality conditions.

This study seeks to examine the optimal circumstances and management practices for the incubation, growth, and production of Magur (*Clarias batrachus*) larvae and fingerlings, focusing on water quality, feeding strategies, and disease management to achieve commercially viable production levels. The larval incubation phase in indoor tanks highlighted the importance of maintaining high water quality. Critical water parameters, including ammonia concentrations (<0.05 $mg.L^{-1}$), dissolved oxygen levels (>4 $mg.L^{-1}$), nitrite concentrations (<0.25 $mg.L^{-1}$), pH (7.0-8.5), and water temperature (27-30°C), were precisely controlled to promote the growth and survival of the larvae. The larvae were maintained in aerated tanks with continuous water circulation, minimizing stress from metabolite accumulation.

It is recommended to have a flow-through system or at least fifty percent on a daily basis. It is recommended that the larvae be cared for in indoor tanks for approximately twenty to thirty days at a stocking density of one thousand to one thousand and five hundred per square meter.

4.4.2 Maintenance of the larval diet

Following the yolk sac has been absorbed, zooplankton including copepods, daphnia, moina, Artemia nauplii, and tubifex are frequently fed to larvae as larval feed. This occurs four days following the day of birth. Up to 15 days postpartum, the animal must be provided live feed; after that, transitioning to formulated feed is recommended. The larvae should be fed at a level that satisfies them twice or three times per day. For larvae, the diet should have at least 30–35 percent crude protein, six different types of live feed (Copepod, Daphnia, Artemia), and ten percent crude lipid. Additionally, the diet should comprise thirty percent fish meal. After thirty days of being reared, the larvae reach a length of twenty to thirty millimeters and a weight of fifty to one hundred milligrams. When it comes to the generation of fingerlings, this is the appropriate size to move to outdoor tanks.

Fig. 3. Procedure for collecting testis samples and preparing a solution containing sperm.

Fig. 4. Gathering and fertilizing eggs

Table 1. List of Water quality parameters

Water quality parameters	Optimum range
Ammonia ($mg.L^{-1}$)	< 0.05
Dissolved oxygen ($mg.L^{-1}$)	>4
Nitrite ($mg.L^{-1}$)	< 0.25
pH	7.0 - 8.5
Total alkalinity ($mg.L^{-1}$ as CaCO3)	90 -150
Total hardness ($mg.L^{-1}$ as CaCO3)	80-150
Water temperature (°C)	27-30

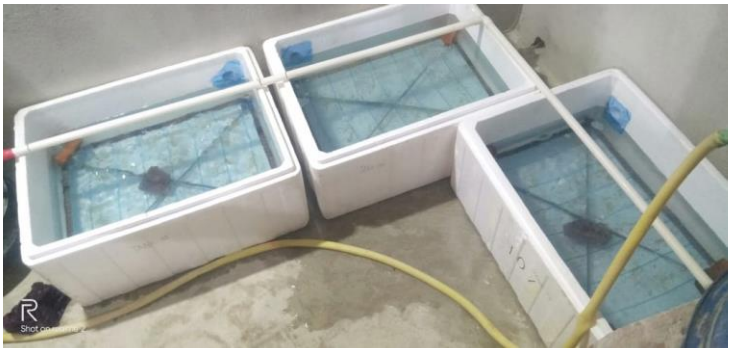

Fig. 5. A flow-through system is used for egg incubation

Fig. 6. Larvae

4.4.3 Cost of seeds and prospective market value

Magur seed is highly sought after in several regions of India. The Government and corporate entities have developed several hatcheries in Odisha, West Bengal, Bihar, Chhattisgarh, Assam, Manipur, Tripura, and other states. Seeds are typically priced between Rs. 1.0 and 2.0 per seed, with a rate of 30dph.

4.5 Production of Magur Fingerlings

4.5.1 Early childhood stage

The fry, which are 30 days post-hatch, are placed at a density of 150-200 individuals per square meter in either cement tanks or nursery ponds for the purpose of cultivating fingerlings. The nursery tanks, ranging in size from 10 to 50 square meters, are equipped with a dirt base of 2 to 3 centimeters in thickness. The water level in these tanks is maintained at 45 centimeters to facilitate the generation of fingerlings. Manure is applied as necessary, similar to a carp nursery, to promote the growth of plankton, which acts as the initial food source for young fish. The Magur fry is fed two to three times daily, with an amount equal to 6-8% of their body weight. They are given feed with 30% crude protein (CP) and 8% crude lipid (CL) to promote optimal growth in advanced fry that are 30 days old. Regular separation and elimination of male plants are essential for improved seed output. The fry attains a weight of approximately 3-5 g during a span of 3 months, making it an optimal size for introduction into a grow-out culture pond.

The grow-out culture of magur is best suited for tiny earthen ponds, stone pitched ponds, or cemented tanks that have dimensions of 0.02-0.1 hectares and a water depth of 0.75-1.00 meters. Typically, it is advised to have a high stocking density of 30,000-40,000 fish per hectare for magur farming. Storing larger-sized seeds (>5 g) leads to increased production, as well as improved survival and growth. Magur, being an air-breathing fish, typically rise to the water surface to obtain atmospheric oxygen. This behavior serves as an attraction for birds to prey on, hence it is advisable to shield the ponds with nets in order to safeguard the fish from bird predation. The following are the steps involved in grow-out production:

4.5.2 Selection of the site and building of the pond

It is not advisable to excavate a pond in a low-lying location due to its susceptibility to flooding during the rainy season. It is necessary to conduct soil testing to determine the extent of water seepage loss. Ponds should be constructed using clayey soil, whereas sandy soils should be avoided. Water should be devoid of any contamination and there should be enough road access to the location of the pond. For optimal management, it is recommended that the grow-out culture ponds have a size ranging from 0.02 to 0.1 hectares.The slope of the pond bund should be between 1:2 and 1:3. The edges of the pond must be lined with stone to prevent erosion, and the water level should be kept at a depth of 1 meter.

4.5.3 Preparation of a pond

To eliminate predatory and weed fishes before stocking, the most effective methods are drying and exposing the pond bottom, or applying mahua oil cake or bleaching powder. The recommended application for carp culture is 2500 kg/ha/m depth of Mahua oil cake or 350 kg/ha of bleaching powder. The application of agricultural lime, at a rate of 200-250 kg/ha, is recommended when the pH of soil and water is above 6.0.

4.6 Fingerling Stocking

4.6.1 Aquatic quality control

Effective water quality management is crucial for the effective cultivation of magur in aquaculture. Metabolites and leftover feed often accumulate in culture ponds, resulting in oxygen loss and ultimately leading to the occurrence of disease and death. Hence, it is recommended to replenish 20-30% of water as needed in order to maintain the water quality parameters at an optimal state. The optimal water quality conditions for the grow-out culture of magur are as follows: The acceptable range for pH is 7.0 to 8.5. The recommended level for dissolved oxygen is between 4 and 6 parts per million (ppm). The total alkalinity should be within the range of 80 to 160 ppm, while the total hardness should also be between 80 and 160 ppm. The total ammonia and nitrite levels should be kept below 0.5 ppm.

4.6.2 Management of feeding

For the growth of magur, it is normally advised to use floating feed that is based on fish meal and contains 30-32% protein. This type of feed offers the best nutrients for optimal growth. The Magur fingerlings are given two feedings every day, with each feeding amounting to 2-3% of their body weight. The feeding rate is modified according to the monthly sampling and feed consumption rate in order to prevent feed wastage.

4.6.3 Health management

Bacteria are prevalent diseases in magur, often resulting in significant losses to the cultivated population. Mortality caused by bacterial infections is frequently linked to environmental stressors. High concentrations of organic matter in pond water can lead to the development of bacterial and fungal illnesses in magur farming.

4.7 Manufacturing and Gathering

Magur reaches a commercially viable size of 100-150g within a culture period of 10-12 months. Harvesting is accomplished by fully draining the pond and manually selecting the fish. Yields of 3-4 tons per hectare can be attained within a cultivation period of 10-12 months. The current market price ranges from Rs 300-600 per kilogram.

5. DISCUSSION

This study's findings underscore the necessity of rigorous water quality management, suitable feeding practices, and disease control to ensure the successful growth and production of Magur larvae and fingerlings. The elevated survival rates and yield outputs underscore the feasibility of Magur aquaculture, especially in India, where market demand for this species is increasing. The flow-through technique utilized in the indoor rearing tanks effectively maintained appropriate water quality, hence minimizing stress for the larvae. The shift from live feed to formulated feed after 15 days was a critical approach for improving the growth and weight of the larvae. The fry demonstrated substantial growth by following a diet high in crude protein and fish meal, rendering them appropriate for grow-out culture. Disease management was a significant

Fig. 7. Magur aquaculture for the purpose of commercial production

Table 2. Symptoms and causative agent

Symptoms	Disease	Causative agent	Control measures
Erythema (redness) at the base of the fins; in and around the mouth; pinpoint haemorrhages	Aeromoniasis	*Aeromonas hydrophila, Aeromonas punctata*	Oxytetracycline at 60-80 mg/kg body weight in feed for 5 days.
Accumulation of fluid in the body cavity; haemorrhages over the internal organs	Abdominal dropsy	*Aeromonas hydrophila*	Potassium permanganate at 5 ppm application in pond or Oxytetracycline at 60-80mg/kg body weight in feed for 5 days
Progressive erosion and disintegration of fins and tail; whitening of the outer margin of the fin	Fin rot and tail rot	*Aeromona liquifaciens, Aeromonas formicans, Pseudomonas fluorescens*	
Ulcerative lesions throughout the body; severe haemorrhagic and necrotic lesions - secondarily infected with bacteria and/or fungi	Epizootic ulcerative syndrome (EUS)	*Aphanomyces invadans*	CIFAX at 1000 ml/ha-m. It controls the disease within 3-7 days.

difficulty in Magur aquaculture. The research emphasized the significance of environmental regulation to reduce stress and organic matter build up, which were associated with the onset of bacterial illnesses. The efficient application of drugs such as oxytetracycline and potassium permanganate facilitated the containment of disease transmission, resulting in healthier populations and enhanced yields. The research presents a framework for the effective cultivation of Magur, from larvae to market-sized fish. Farmers can attain high yields and marketable fish during a 10-12month culture period by ensuring water quality, improving feeding tactics, and managing illnesses. The results have considerable ramifications for aquaculture operations in India, where Magur farming presents both economic prospects and avenues for sustainable fish production.

6. CONCLUSION

Several farmers have started cultivating C. magur in response to the significant market demand for this particular species of catfish. A multitude of hatcheries have been created in the eastern states of India. However, there is still a lack of sufficient seed supply in terms of both quantity and quality. This could be attributed to constraints in the resources accessible to farmers. In recent years, research institutes have prioritized the training of new farmers and assisting them in establishing hatcheries. The ICAR-CIFA has created a capsule form of seed production and culture technology for C. magur, which encompasses all the necessary activities for its widespread adoption and effective cultivation. Therefore, there is an increased prospect for achieving self-sufficiency in the cultivation of this catfish in the near future.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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