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Freshwater prawn aquaculture: Prospects in U.P

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Abstract
Uttar Pradesh is rich in freshwater fish biodiversity and shares about 14.68% of the total fish biodiversity in India. The main fisheries resources comprise of rivers, ponds, canals, irrigation, all fields, reservoirs etc. Rivers and canals encompass a total length of about 3945km. There are 251 hectares in the state for quality fish seed production. In freshwater aquaculture, prawns are potential candidates. Out of the 200 species of freshwater prawns, *M. rosenbergii* is most favourable cultured species due to its rapid growth and high demand in markets. Uttar Pradesh has ideal conditions for freshwater prawn aquaculture but it is not being utilized for sustainable culture. Smaller freshwater prawns "a untapped resource" may also be used for freshwater aquaculture. In the present study, an attempt has been made to review the current status of freshwater prawn aquaculture in Uttar Pradesh and and locally available freshwater prawns, *M. lamarrei* and *M. dayanum* as potential candidate for land locked state like U.P.

Keywords: Freshwater aquaculture, freshwater prawn, Uttar Pradesh, *Macrobrachium lamarrei* and *Macrobrachium dayanum*

Introduction
Aquaculture is one of the most significant fisheries sectors in India having growth rate of over 7% per year. Today, India holds fourth position in culture fisheries production (FAO, 2018) [7]. Aquaculture provides dietary supplements for human food as well as creates enormous opportunities for employment, particularly in rural areas. Freshwater aquaculture in India has shown a rapid growth over the last 2 decades and contributes over 95% of the total aquaculture production. The inland fisheries have demonstrated rapid growth over the last few decades and has been increased to about 80% over the last few year (FAO, 2018) [7].
Crustaceans are important members of food chain and relished as food since antiquity. Prawns, shrimps, crabs, lobsters etc are included in human diet. It has free amino acids, vitamins, proteins lesser in fat and carbohydrate therefore advised to diabetic people (Proudfit and Robinson 1955, Martin 1966, Singh, 1977, Khan *et al*.,1994) [33, 28, 51, 13].
It supports the livelihood of 10-12% of world population (FAO, 2016) [6]. Currently, aquaculture is responsible for nearly half of the global food fish consumption (Subhasinghe *et al*., 2009). Freshwater aquaculture is an important sector of fisheries research. Jayasankar (2018) [11] has documented a review on the status of freshwater aquaculture in India. However, no comprehensive review has been documented on the status of freshwater aquaculture in U.P. Crustaceans culture comprises mainly marine prawn, shrimps, crabs, lobsters. Nowadays demand has increased towards freshwater prawns in local and global markets which shifted attend towards freshwater prawn aquaculture. Therefore, in the present paper an attempt has been made to review the current status of freshwater aquaculture in Uttar Pradesh.

Global and local Scenario of Prawn Production:
The secondary data for the present study was collected from several sources which mainly include FAO (2018) [7] and Handbook of fisheries statistics, 2020, published by Department of Fisheries, Government of India.

Freshwater aquaculture production at global level:
The fish production at global level has been reached about 179 million tones as of 2018 and of which 156 million tones were used for human consumption.

In 2018, total capture global fisheries have witnessed an increase of 5.4% and reached at 94.5 million tones. Global aquaculture production has been reached to 114.5 million tons in 2018.

Total production of shrimps has seen an increase of 5% and reached to 5 million tons in 2021 (FAO, 2019) [8]. The area available for shrimp farming in India is around 160,000 hectares. In 2018, India has reached the highest level ever recorded at 700,000 MT but estimated production to fall 600,000 MT by 2021.

Freshwater aquaculture in Uttar Pradesh, India

Uttar Pradesh shares about 14.68% of the total fish biodiversity in India (Lakra, 2010) [16]. It is most populated state of India having rich freshwater fish diversity (Pathak *et al*., 2019) [32]. The demand of fish production in U.P. is nearly 15 lakh matric tones whereas the total production is quite lesser that is 4.9 lakh matric tones (NFDB Newsletter, 2016).

Rivers, ponds, irrigation canals, reservoirs etc. are the main fisheries resources. Despite having sufficient resources for freshwater aquaculture, they are not utilized enough and have enormous scope to improve food security of U.P. Rivers and canals are one of the major resources for fisheries having total length of 39,542 km (Department of Fisheries U.P., 2020) [4]. The livelihood of fisherman in the vicinity of rivers are dependent on fisheries resources of the rivers.

Apart from riverine system, reservoirs are one of the most important fisheries resources in India. There are total 94 reservoirs in Uttar Pradesh encompassing total are of 64,889.87 hectares (Department of Fisheries, U.P., 2020) [4]. Balrampur, Chitrakot and Behraich have maximum number of small reservoirs (40-200 hectares) (Department of Fisheries, U.P., 2020) [4]. Ponds are also considered as one of the most important sites for aquaculture. In Uttar Pradesh, revenue ponds encompass an area of 1, 50, 482.50 hectares (Department of Fisheries, U.P., 2020) [4]. The ponds may be used as a potential source for freshwater aquaculture. Uttar Pradesh has capacity of developing 60,000 hectares of additional ponds for aquaculture. Pangasius farming includes an area of 835 ha in Uttar Pradesh (Department of Fisheries, U.P., 2020) [4].

In order to fulfill the requirement of quality fish seeds in U.P, there are 251 hatcheries in the state (Department of Fisheries U.P., 2020) [4]. Apart from this, there are 77 feed mills in the state (Department of Fisheries U.P., 2020) [4].

(B) Freshwater Prawn Culture

Freshwater prawns are potential candidate for aquaculture and they are good source for vitamin A & D, free amino acids and proteins. Owing to their high nutritional value, their demand is high in national and International market (Sankar *et al*., 2011, Ahmed *et al*., 2021) [36, 1]. India holds second position in export of freshwater prawn in the world market (Balamurgan *et al*., 2004) [3]. The total production of freshwater prawn in India amounts 30,450mt and encompasses an area about 34,630 ha (Sakthivel 2003; Balamurgan *et al*., 2004) [35, 3]. India contributes about 42% of the total aquaculture production of prawn worth 579 US $ million (Sakthivel 2003; Nair *et al*., 2007) [35, 30]. India has rich resources for the aquaculture of freshwater prawns that may be utilized for commercial farming of marine and freshwater prawns both (Pandey *et al*., 2009) [31].

Freshwater prawn *M. rosenbergii* farming breakthrough was discovered by Shao. Wen Ling in 1962. The unique thing about this discovery was that its larvae needed brackish conditions for their survival and development. It was observed that the larvae of freshwater prawn required brackish water in order to survive more than 5 days (Ling, 1977) [17]. This discovery led to culture of juvenile prawns to commence grow out culture in pond (Ling and Costello, 1979) [18]. Takuji Fujimura was the pioneer researcher to introduce freshwater prawn culture at commercial level.

There are almost 200 species of freshwater prawns, out of which *M. rosenbergii* is widely cultured species commonly called as "Scampy". It is a giant prawn, suitable for aquaculture owing to its resistance to diseases, rapid growth rate and high demand in national and international markets (Pandey *et al*., 2009) [31]. Polyculture with fishes like grass carp, silver carp, rohu etc may help in aquaculture in pond resources (Radheshyam, 2009) [34]. Being a commercially important species, giant freshwater prawn, *M. rosenbergii* are being cultured in several states such as Kerala, West Bengal, Andhra Pradesh, Orissa, Haryana, Punjab, Maharashtra (Sakhthivel, 2003; Singh, 2003) [35, 52].

There is high demand for larger freshwater prawns such as *M. rosenbergii* in national and international markets (Kanoujia, 2006, Upadhayay *et al*, 2006) [12, 63]. Yet the culture of these prawns is difficult in non-coastal areas such as Uttar Pradesh, M.P., Punjab, Bihar and Haryana despite having rich resources for freshwater aquaculture (Shukla and Sharma, 2010) [44]. The larger species of prawns require brackish water for their larval development hence it is costly to transport them. Apart from this, these prawns have long larval period. Therefore, the environmental stress may lead to less success rate upto post larval period (Shukla and Sharma, 2010) [44].

Despite high demand of *M. rosenbergii* "scampy" there are certain disadvantages in culture of larger prawn species like, they need brackish water for larval development, hatcheries are set at sea coast therefore seed transport make it expensive, long larval period makes them more vulnerable to environmental stress and success rate upto post larva is very less; prawns processing unit are not set throughout India; Culture cannot successfully performed in natural water reservoirs therefore productive land is used which is not ecofriendly ; Due to high price they do not cope up nutritional demands of common and poor people of India.

Despite having suitable conditions for prawn aquaculture in Uttar Pradesh, it is not being utilized for commercial purposes (Janaki Ram & Pandey, 2003; Sultan, 2003) [10, 54]. Besides giant freshwater prawn smaller prawns may also serve as a potential animal for freshwater aquaculture. Smaller freshwater prawn, *M. nipponense* is being cultured in China for commercial purpose (Kutty, 2003) [15]. *M. amazonicum*, *M. acantharus* & *M. carcinus* are being used for freshwater aquaculture in African countries (Pandey *et al*., 2009) [31]. Smaller prawns like *M. lamarrei* & *M. dayanum* being a good source of nutrient rich food may be used for freshwater aquaculture in Uttar Pradesh (Shukla & Sharma, 2010) [44].

(C) Possibilities of Culture of smaller freshwater prawns:

Other alternatives must be utilized in order to provide better nutrition and economic growth. Smaller freshwater prawns may be used as a better candidate which are readily consumed by the local population and still not promoted the way they should be (Shukla and Sharma, 2010) [44].

(D) Attempts of smaller freshwater prawn culture outside in India:

M. nipponense was first smaller freshwater prawn to be cultured in China, which paved the way for new avenues for freshwater aquaculture (Kutty, 2003) [15]. The culture of smaller freshwater prawns such as *M. jelskii, M.borelli, M. quelehi, M. potunus, M. brasilience, M. iherigi* was recommended by Dobkin (1967). In Africa, species of smaller freshwater such as *M. amazonicum, M. vollenhovenii, M. acaranthus and M. carcinus* are being cultured (Nakata *et al*., 2004). *M. lamarrei*, a smaller and translucent prawn have been cultured in Bangladesh, Phillipines and Malaysia. Another smaller prawns, *M. lanchesteri* have been successfully cultured in Thailand, Vietnam and Malaysia (New & Valenti, 2000).

(E) Attempts in India:

Indian rivers and water reservoirs are enriched with small freshwater prawn species having high aquaculture potential (Kurian & Sebastian, 1993). The species of smaller prawns which are commonly found in India are *M. lanchesteri, M. equidens, M. nobilli, M. mirabile, M. idella, M. lanchesteri, M. scrabiculum, M. rude, M. lamarrei* and *M. dayanum* etc. Being smaller size, having abbreviated development and resistant to diseases than larger prawn species, these prawns are better option than larger freshwater prawn species.

Advantages of smaller prawns over larger prawn species: -

1. They have abbreviated development, fully completing in freshwater therefore seed can be obtained locally and hatcheries can be set in all parts of country.
2. Availability of seed in local rivers throughout year.
3. Despite low fecundity, they have short larval period and high survival rate which makes them better suited for culture.
4. Resistant to disease than larger prawn species.
5. Culture can be performed in natural water reservoirs therefore ecofriendly.
6. Due to smaller size they can be sun dried and stored for longer period.
7. Polyculture of these prawns with common fishes is possible.

Freshwater prawn *M. lamarrei* and *M. dayanum* (Fig 1& 2) have been thoroughly studied in Prawn Research Centre Department of Zoology, University of Lucknow (U.P.), India and Department of Zoology, BSNV PG College, Lucknow (U.P), India. Sharma *et al*., (1997) [42], firstly reported *M. dayanum* (Henderson) from Gomti river, Lucknow.

M. lamarrei (H. Milne Edwards) is a smaller, freshwater prawn which is translucent in appearance. Its size ranges from 30-55mm in length (Mean= 48.6+_ 5.5mm) and 1.107+_0.26 gm in weight. The exoskeleton is covered with light green and some brown chromatophores. Fecundity ranges from 55-250 (Shukla, 1988) [46].

M. dayanum is another species of smaller prawns found in river Gomti. Its size ranges from 35-65mm in length (Mean= 56.4+_4.2mm) and average weight 3.26+_ 0.68gm. They are dark in colour due to blue and brown chromatophores over their exoskeleton. Fecundity ranges from 38-142 (Tripathi *et al*., 2021) [60].

Plate 1

Fig 1 & Fig 2 Explanation of Figure:- Freshwater parwns reported in Gomti river, Lucknow (UT), India

Fig 1: *Macrobrachium lamarrei* **Fig 2:** Macrobrachium dayanum

(F) *M. lamarrei* and *M. dayanum* as test model for lab and environmental monitoring

- These smaller prawns may be used as a good laboratory model for toxicological studies and environmental monitoring (Shukla *et al*., 2010) [44]. They are used as a model animal for following reasons: -
- Their smaller size enables them too easily in laboratory conditions.
- They are easily available throughout the year.
- The omnivorous nature leads to easy and less costly maintenance.
- They are highly sensitive to environmental pollution. Therefore, they may be used as a better bio-indicators.
- The translucent colour facilitates studies of parameters like scaphognathite oscillations, heartbeat etc via non-invasive method.

- The outcome of the studies may be useful in improving commercial aquaculture of freshwater prawns.

(G) Laboratory studies on biology of Prawns

The biology of both the prawns have been thoroughly studied in this lab. Some of the important studies are-

- Digestive physiology and Ultrastructure (Shukla & Sharma, 1990, Sharma & Shukla, 1992) [43].
- Heart and hemocytes (Lodhi *et al*., 2004, Lodhi *et al*., 2008, 2009, Lodhi & Shukla, 2021) [21, 20, 26, 24, 21, 24]
- Reproductive biology (Tripathi, 2007, Tripathi *et al*., 2019; Tripathi *et al*., 2021) [59, 62, 61, 60].
- Neuroendocrine system (Tewari *et al*., 2008) [55]
- Receptor biology (Sharma and Shukla, 1990) [43].

Some of the important toxicological studies are-

Effects of heavy metals Cd, Cu, Cr, Ni, Pb and detergents linear alkyl Benzene sulphonate (LAS) on several parameters such as: -

Histopathology of hepatopancrease, gills, green gland, heartbeat, haemocyte morphology, sperm morphology and neurosecretory cells (Shukla, 1993, Shukla & Sharma, 1993, Shukla & Sharma, 2002, Lodhi *et al*., 2002, 2007 a& b, 2008, Sen *et al*., 2008, Lodhi, 2009, Shukla *et al*., 2013; Shukla *et al*., 2019; Shukla *et al*., 2021) [48, 49, 37, 38, 24, 50, 47, 45]

General behaviour patterns (Shukla & Sharma 1990, Verma *et al*., 2005, Sharma & Shukla, 2006, Lodhi *et al*., 2006, Tewari *et al*., 2007, Tripathi *et al*.,2007, Sharma *et al*., 2008, Tewari *et al*., 2009; Ahmed *et al*., 2021) [43, 66, 40, 41, 55, 59, 62,,39, 1].

Scaphognathite oscillations (Tewari *et al*., 2008, Sen *et al*., 2008a & b, Verma *et al.*, 2007; Verma *et al*., 2010) [64].

If these parameters are properly standardized then various parameters can serve as better bio-marker and these prawns can serve as better bioindicators.

Conclusion

Freshwater aquaculture of fishes is increasing rapidly and the current production is about 632 thousand metric tons. Based on the data collected in the present study, it may be concluded the ponds are mostly used resources for freshwater aquaculture in Uttar Pradesh. Uttar Paresh is rich in resources such as reservoirs, rivers, ponds etc, which are majorly unutilized and need to be used for enhancing fish production in the state (Kumar *et al*., 2020). Loss of natural habitats, exotic species over fishing has caused decline in fish production from rivers. This need to be curb down via enactment of strict rules and regulation for sustainable utilization of rivers (Maurya *et al*., 2018) [29]. Prawn aquaculture is a recent and profit -making industry (Pandey *et al*.,2009) [31]. Freshwater prawn culture in India is prevalent in about 34,630 ha with a total production of 30,450 mt (Balamurgan *et al.*, 2004) [3]. Though, Uttar Pradesh is rich in freshwater resources and have ideal conditions for prawn aquaculture it is yet to be explored and utilized in the state (Sultan, 2003) [54]. Smaller prawns, *M. lamarrei* & *M. dayanum* "an untapped resource" can be future prospective along with the culture of larger prawn species.

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