EFFETIVENESS OF WATER QUALITY PARAMETERS ON BREEDING OF GOURAMI *(TRICHOGASTER TRICHOPTERUS)*

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Abstract:

In the present study, effect of seasonal water quality parameters on the breeding performance of three spot gourami, "*Trichogaster trichopterus* was evaluated in captive red ornamental fish culture condition, at Kodoli a village of Kolhapur district, Maharashtra, India. The annual investigation was carried out in three seasons (winter, summer, monsoon) in order to find the influence of the changes in these variables (temperature, Total Dissolved Solids (TDS) etc.) on the level of successful spawns, hatching, larval survivability and deformities. Standardized breeding system consisting of 1:1 male-female ratio in a Completely Randomized Design (CRD) was used. Standard procedures were used to monitor the following key water quality parameters: temperature, pH, dissolved oxygen, hardness, TDS, saltiness, ammonia, nitrite, and nitrate. These results showed that cold stress resulted in complete failure of breeding in the winter, (mean temperature 21°C). In summer season there was moderate spawning at 29°C, but fry survival was poor (2.5% at 30 days) and proportion of deformities was more (32.5%). Although higher mean temperature (25°C) during monsoon season had high TDS (400 ppm), considerable higher breeding performance (70% and 20% hatching and fry survival at 30 days respectively) was observed. The study proved that temperature and TDS are important factors to consider with respect to breeding efficiency of gourami. It has been found that moderate TDS (200–300 ppm) and near-optimum temperature (25–29°C) greatly benefit spawning and larval production, in the culture of ornamental fish.

Keywords: Gourami breeding, water quality parameters, temperature, TDS, seasonal variation, hatching rate, larval survival, ornamental fish culture

***IndexTerms* - Component,formatting,style,styling,insert.**

1.INTRODUCTION

It is the three-spotted gourami, *Trichogaster trichopterus*, that has become one of the most popular ornamental fishes in the aquarium trade worldwide for its beautiful colours, hardiness and tolerance to varying environmental conditions. The gourami, *Trichogaster trichopterus* is a labyrinth fish belonging to the family Osphronemidae and has a highly specialized respiratory organ that allows it to absorb the oxygen from the air, in view of the scarce amount of oxygen in water. Grows throughout Southeast Asia and is now a widespread practice in India as a small-scale ornamental fish. Considering its breeding by bubbles, care provided by the males and reasonably high fecundity, it is an excellent animal for captive breeding studies. Accurate water quality management, however, is a very critical requirement during spawn and early development phases to have successful spawning, egg development and larval survival.(Patel et al., 2022)

Water quality parameters are important factors that affect reproductive ability and survival of ornamental fishes. Metabolic activity, endocrine regulation, gamete viability, fertilization success and embryonic development are all affected directly by the temperature, pH, dissolved oxygen, hardness, ammonia, nitrite, nitrate, salinity, and total dissolved solids (TDS) status of the water. Any slight deviations from optimum ranges can elicit a stress response that interfere with spawning behavior, hatching rates, and increase larval deformity. In these parameters, temperature is generally acknowledged as a dominant one on the breeding cycles of tropical fishes. Impacts enzyme activity, hormone levels and courtship behavior including nest building. The role of dissolved minerals and salts (TDS) is just as significant as that of ammonia for osmoregulation, ion exchange, egg hydration and larval development. Optimum levels of these parameters are thus crucial to successful gourami breeding. Groundwater chemistry and ambient temperature in these tropical areas, like Maharashtra, are highly seasonal and will impact the success of ornamentals/mustelka production. Those with a substantial temperature range are often having problems in maintaining consistent breeding conditions, reduce production and economic losses to small scale breeds. Conversely, moderate climate would result in more favorable natural conditions for propagation of ornamental fish in moderate TDS, stable groundwater quality; lower TDS and stable groundwater quality would result in the same. Higher levels of rainfall and moderate seasonal variation are the features of the western part of the state in Sahyadri belt, with better groundwater quality than less rainy areas of Marathwada. The ecological parameters of Kolhapur are suitable to study the effect of seasonal changes in water quality on gourami breeding. The eco-parameters of Kolhapur is ideal to study the effect of the seasonal variability of water quality on gourami breeding. (Paulpandian et al., 2023)

To breed gourami with the three spot, temperature and lighting along with certain behavioural needs must be met. The male forms a bubble nest on the water, with a mixture of mucus and bubbles, and frequently with floating vegetation. Egg setting, courtship and nest com-positioning will not occur if the water surface is not calm, the temperature is not appropriate, or the mineral balance is not correct. Male incubates the nest and protects the eggs until the young hatch. At this stage, exposure to unfavourable water conditions, high TDS or high temperatures may result in egg mortality, fungal infections and developmental abnormalities. The larvae after hatching are very sensitive to water chemistry changes, including a build-up of ammonia, hardness and ionic concentration and can suffer high mortality or deformities. It is this highly seasonal water quality that has an impact in these stages and which needs to be understood in order to optimise breeding. While earlier studies are focused on the water quality influence on ornamental fish production, few field-based research studies have considered the relation of seasonal changes in groundwater to the breeding performance of gourami under on-farm production. The research available has taken place in the laboratory setting and are not fully representative of the problems encountered by the small-scale ornamental fish farmers relying primarily on untreated borewell or groundwater. Observation of the effects of natural seasonal variations in water temperatures, TDS, spawning success, hatchability rates, fry survival and incidence of deformity can make practical recommendations to help optimize spawning management. Based on this, the present study investigated the effectiveness of some water quality parameters on breeding performance in *Trichogaster trichopterus* during the three seasons namely, winter, summer and monsoon seasons under the environmental condition of Kolhapur. Taking measurements of the water chemistry during different seasons of the year and comparing them with the reproductive parameters, the results are expected to reveal the optimum conditions for the success of egg-laying and rearing larvae. The results will be used to develop aquatic quality management strategies specific to each season to increase the efficiency of breeding, fry survival, and reduce deformities and make the ornamental gourami culture efficient and profitable in similar agro-climatic conditions.(Hodges & Behre, 1953)(Zuanon et al., 2004)(Marcelino et al., 2025)

NEED OF THE STUDY.

- To evaluate the effect of seasonal water quality parameters on the breeding performance of Gourami (*Trichogaster trichopterus*).
- To study the influence of temperature and Total Dissolved Solids (TDS) on spawning success, hatching rate, and fry survival.
- To identify the most favourable seasonal conditions for successful captive breeding of Gourami under ornamental fish culture conditions.

2. LITERATURE REVIEW

(Sahoo et al., 2025) To assess the reproductive performance and larval rearing of the dwarf gourami, *Trichogaster lalius* (Hamilton, 1822) response to nutritional interventions in captive condition for 90 days, were assessed. Four diets were tested to do reproductive performance measures. Treatment 1 and 2 were given formulated feed with 0% and 4% of supplementary diet mix (SDM) respectively. Ingredients of SDM include, Refined lecithin, α Tocopheral acetate, L-ascorbic acid, Spirulina powder and L-tryptophan. Live feed (Tubifex) was fed to Treatment 3 and a combination diet (live feed + 4% SDM formulated feed) was fed to Treatment 4. Both male and female dwarf gourami had the maximum gonad weight and gonadosomatic index (GSI) in Treatment 4. Spawning was successful in only Treatment 3 & 4. After 60 days, fertilisation rates in Treatment 3 and 4 were 65.33±1.76 and 70.67±0.67% respectively, while hatching rates were 35.33±1.76 and 42.00±1.15% respectively. The fertilisation and hatching success of the combination diet (Treatment 4) was better. Larval rearing was done in a 30 days experimental trial with 100 number of larvae stocked per 10 l water each of the trials was in triplicates. The three feeding trials were carried out in three different cultures, namely: treatment-I fed live feed which is infusoria, treatment-II fed with 4% SDM formulated food and treatment-III fed boiled egg yolk. Larval length gain (+10.54 ± 0.07 mm) and survival rate (+66.33 ± 0.88%) were found to be the maximum at Treatment.

(Degani et al., 2021) Genetic differences between species are characterised by their value for applied research and for basic research. Various genes of model labyrinth fish, such as blue gourami (*Trichogaster trichopterus*) are discussed here in this context as growth and reproduction related genetic markers of genetic variations. Genes coding for the following hormones are described: Genes coding for kisspeptins 1 and 2, genes coding for gonadotropin-releasing hormones 1, 2 and 3, genes coding for growth hormone, somatolactin, prolactin, genes coding for follicle-stimulating hormone and luteinizing hormone, and mitochondrial genes coding for cytochrome b and for 12S rRNA. Genetic markers from the bluestone found in blue gourami represent a suborder of the bony fishes (Anabantoidei), which are distinct. Mitochondrial cytochrome c oxidase subunit 1 (COI) gene sequence of the blue gourami is commonly used to analyse the Anabantoidei suborder. Among the genes involved in controlling growth and reproduction, the most suitable genetic markers for distinguishing between species of the Anabantoidei have functions in the hypothalamic–pituitary–somatotropic axis: pituitary adenylate cyclase-activating polypeptide and growth hormone, and the 12S rRNA gene.

(Swain et al., 2021) The natural stock of Trichogaster chuna (Hamilton, 1822) are gradually declining due to destruction of its habitat and over fishing, continuous exploitation of their wild populations might endanger them. This article compares the breeding qualities of the honey gourami at various stocking densities at indoor aquarium using various nest substrate during nest construction and with different embryonic development and rearing of larvae. A total of 200 mean worm length (37 mm) ± 3.06 and mean worm weight (1.09 ± 0.27) Trichogaster chuna were collected from ornamental fish markets. Broodstock raising of honey gourami was carried out using mixed zooplankton and live tubifex along with floating pellets thrice a day. Five treatments in triplicates as part of the evaluation breeding performance with different breeding substratum such as bermuda grass (Cynodon dactylon), hydrilla (Hydrilla verticillata), cut banana leaf, eichornia plants (Eichhornia crassipes) and thermocol (polystyrene). Better breeding results were seen in Bermuda grass followed by hydrilla and banana leaf in the case of number of eggs released and hatchlings produced. Embryonic development stages were observed and characteristics of each stage of development were noted.

(Davis et al., 2019) The most important resources in an aquatic ecosystem for aquaculture are the live food organisms (LFO). A remarkable accomplishment in the livestock based feed that has led to better survival, increased growth rates and enhanced resistance to stress. The study on comparative feeding preference of various ornamental fishes such as Mosquito larva, Bloodworms and Earthworm with *Trichogaster trichopterus* (Gourami), Puntius conchonius (Rosybarb), Cyrtocara moorii (Blue Dolphin cichlid), Poecilia sphenops (Blackmolly) and Poecilia innesi (Neon tetra) has shown that the fishes were fed at 3 feeding and had a preference for bloodworm and mosquito larvae. Fish find live foods primarily through olfaction (smell) and sight—not by appearance, feel or taste of live foods. In the short time duration the Puntius conchonius fish consumed more number of mosquito larvae (34.8±7.0mg) than *Trichogaster trichopterus* fish consumed (29.4±4.23mg) and more number of earthworm (34.8±7.0mg) than *Trichogaster trichopterus* fish consumed (29.4±4.23mg). The fishes selected can also be used as feed for the larvae in mosquito management and can be utilized for aquarium fish production as alternative source feed to reduce the expensive feed cost using the inexpensive resources of these larvae which are indeed suitable for the selected fishes.

(Iskandariah, 2014) The Siamese gourami, Trichogaster pectoralis, was first imported in 1934 from Siam (now Thailand) to the Republic of Indonesia, and is a significant species in aquaculture that also has wild stocks threatened by overfishing and habitat loss. Genetic and phenotypic diversity in nine populations of Sumatra, Java and Kalimantan were assessed by RAPD markers and truss morphometrics for the purpose of domestication and selection of sustainable farming. Thirty fish were collected from each site and measured morphometrically and the following fin samples from ten fish were extracted using phenol–chloroform method and then genotyped by PCR. The level of genetic diversity of natural populations in East Java (65.62%), Lampung (59.37%) and Palembang (56.25%) was high, while in West Java (31.25%), West Kalimantan (21.87%) and Central and South Kalimantan (6.25–12.5%) was low. The dendrogram indicated that the clusters were most distant from each other in West Java and South Kalimantan and the next most distant cluster was in East Java, Lampung and Palembang. The ratio of morphometric uniformity was highest in Central Java and West Kalimantan.

3. MATERIALS AND METHODS

3.1 Experimental Site

The present investigation on breeding performance of Gourami *Trichogaster trichopterus* was carried out at taluka Kodoli, District Kolhapur, Maharashtra, India near the Sahyadri region. Since the study area had favourable climatic and groundwater conditions to the production of ornamental fish, it was considered appropriate for the present study. The temperature variation is comparatively less in the Sahyadri region of Maharashtra as compared to the other regions of Maharashtra. Temperatures vary from a minimum of approximately 18°C in the winter to a maximum of 35°C during the summer. The places like Marathwada on the other hand experience extreme heat (winter 12° below and summer more than 45°) which affects the ornamental fish breeding activities. The Kolhapur region also gets comparatively more rainfall and has less" quantity of Total Dissolved Solids (TDS) in groundwater in comparison with many other regions.

3.2 Experimental Fish

Trichogaster (also known as Gourami) Fish were collected from local ornamental fish breeder in good health and sexually mature condition. "Secondary gender characteristics like body colour, dorsal fin shape, and abdominal bulge in the females were used to determine the gender of brooders. Borewell water was used in the brooders and the brooders were acclimatised for 15 days before the experiment was done. Acclimatization was conducted in two stages where the fishes were fed twice a day with commercial ornamental fish feed of about 30–35% of crude protein level.

3.3 Experimental Design

This experiment was carried out at different seasons, which are: Winter, Summer, Monsoon. A completely randomized design (CRD) was used for the present study. A 1:1 ratio of male to female was used in the breeding trials, as the ratio is well recommended for the breeding of Gourami under captivity. One male together with one female fish was reared in one separate breeding unit. Male fish were placed into the tanks with the aid of aquatic plants and floating beaded thermocol sheets to help them build bubble nests.

Figure 3.2 Bubble Nest Construction by Male Gourami

3.4 Breeding Tank Preparation and Management

Gourami were bred in the glass aquaria of the suitable size. Tanks were cleaned and disinfected fully before stocking to guarantee hygienic stocking. The water level was kept 20–25 cm deep to ensure freedom of natural breeding behavior and nesting activities. Dissolved oxygen maintained steady throughout the year, and was held above 4.0 mg/L by performing partial water exchange, which was done periodically (20–30%). Spawning, hatching and larval development were successful with key parameters kept within ideal ranges: temperature 23-29°C, pH 6.0 - 7.5, ammonia and nitrite below 0.5 ppm, nitrate below 40 ppm, hardness 50-150 ppm, salinity zero and for the most part TDS seasonally varying.

Figure 3.1 Breeding Tank Experimental Setup for Gourami

3.5 Seasonal Variation in TDS

The total dissolved solids (TDS) content of the underground borewell water was observed during the observation period as it is a very important parameter for osmoregulation, fertilization, egg development, hatching and larval survivability of ornamental fish breeding Gourami. The TDS measurements recorded were found to be changing significantly from one season to the next, from 280 – 320 ppm in winter, 200 – 300 ppm in summer and 350 – 450 ppm in monsoon. These differences have been carefully recorded to determine how they do effect breeding productivity. By providing monitoring of TDS, appropriate water quality conditions could be maintained, which have direct effects on reproductive efficiency and early larval development, when dissolved solids levels are either too high or too low.

3.6 Water Quality Analysis

Standard water quality procedures recommended by the American Public Health Association were used and sampled every day during the breeding season. Parameters measured were: temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, hardness and total dissolved solids (TDS); salinity was also measured. Digital thermometer was used to measure the temperature and a digital pH meter to measure acidity and alkalinity. Dissolved oxygen (D.O.) concentration was determined by a DO meter. Water testing kit used to measure the concentration of ammonia, nitrite and nitrate. The water was tested for hardness by using a digital water analyzer, TDS by using a TDS meter and salinity by using a refractometer. Water quality changes throughout breeding were systematically documented.

3.7 Breeding Performance Evaluation

Key reproductive indices were used to determine the efficiency and the viability of breeding Gourami standards in terms of larval production. The parameters considered were spawning success, total number of eggs laid, hatchability, survival rate at 7 days, survival rate at 30 days and percentage of deformities noticed. The spawning success was verified by successful egg deposition and fertilising. Eggs were laid manually and the total laid recorded. Hatching rate was defined as the percentage of eggs which hatched successfully. Survival was calculated by the number of larvae surviving at specific time intervals and deformities were noted and recorded by visual inspection to determine general quality of breeding stock and fitness of larvae.

Figure 3.3 Fertilized Eggs in Bubble Nest

The egg cells are fertilized when they attach themselves to the sides of the nest's internal bubble walls (see Figure 3.3). The success of spawning was evaluated by success in egg laying and fertilization. After spawning the total number of eggs were manually counted. Hatching percentage was determined by the following formula:

$$\text{Hatching Rate (\%)} = \frac{\text{Number of Hatched Larvae}}{\text{Total Fertilized Eggs}} \times 100$$

Survival rate was calculated at 7 days and 30 days after hatching using the following formula:

$$\text{Survival Rate (\%)} = \frac{\text{Number of Surviving Fry}}{\text{Total Hatched Larvae}} \times 100$$

Larvae showing abnormal body shape, spinal curvature, fin deformities, or developmental abnormalities were counted and expressed as percentage deformities.

Statistical Analysis

The collected data were analysed seasonally and tabular and graphical form that shows the effect of water quality parameters on breeding performance of *Trichogaster trichopterus*.

3.9 Standard Breeding Protocol Adopted

The following standard ornamental fish breeding protocols were adopted during the study:

- Male: Female ratio = 1 : 1
- Maintenance of stable temperature conditions
- Use of low-stress soft water
- Regular monitoring of TDS and dissolved oxygen
- Provision of floating materials for bubble nest formation
- Controlled aeration and periodic water exchange

These standardized management practices improved spawning efficiency, hatching success, and larval survival during the experimental period.

4. RESULTS AND DISCUSSION

The present study aimed to assess the impact of the water quality parameters during various seasons on breeding performance of Gourami (*Trichogaster trichopterus*). Spawning success, hatchability, survival of fry and deformities" were greatly influenced by changes in temperature, TDS, pH, DO and hardness. Seasonal comparisons showed that favourable environment for breeding and larval growth resulted when monsoon weather conditions occurred.

4.1 Seasonal Variation in Water Quality Parameters

During the breeding experiment of "*Trichogaster trichopterus*, water quality parameters were recorded with variation from the seasons, this is displayed in Tables. The mean values were used as representative values from the observed ranges for each season for the parameters. Results revealed temperature conditions for winter season were comparatively low and resulted in cold stress and total breeding failures. Environmental condition during summer and monsoon period were relatively suitable for breeding activities but excessive summer temperature and monsoon TDS had negative impacts on the survival and percentage of deformity of fry.

Table 4.1 Winter Season Water Quality Parameters (Dec–Feb)

Parameter / Unit	Optimum Range	Winter
Temperature (°C)	23–29	21.0 ± 0.5
pH	6.0–7.5	7.6 ± 0.1
Dissolved Oxygen (mg/L)	> 4.0	7.0 ± 0.3
Ammonia (ppm)	< 0.5	0.15 ± 0.02
Nitrite (ppm)	< 0.5	0.05 ± 0.01
Nitrate (ppm)	< 40	12.5 ± 1.0
Hardness (ppm)	50–150	100 ± 4
Salinity (ppt)	0	0.15 ± 0.01
TDS (ppm)	Low preferred	300 ± 10

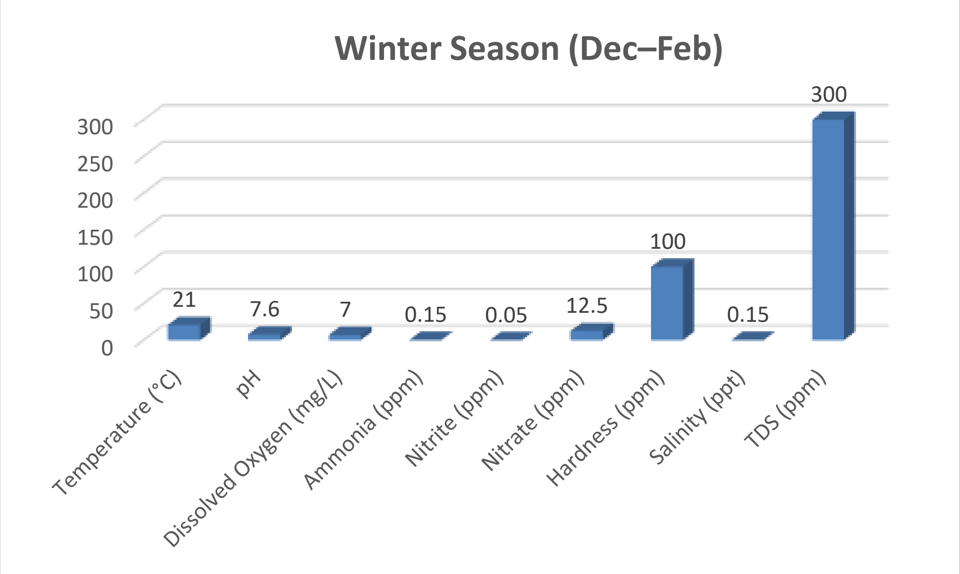

Figure 4.1 Winter Season Water Quality Parameters

The temperature recorded during the winter seasons (21°C) was below the optimum breeding range and this caused cold stress and breeding failure. Other parameters were within acceptable range and still temperature is shown to be the most limiting factor for the Gourami breeding performance.

Table 4.2 Summer Season Water Quality Parameters (Mar–May)

Parameter / Unit	Optimum Range	Summer
Temperature (°C)	23–29	29.0 ± 0.6
pH	6.0–7.5	8.0 ± 0.1
Dissolved Oxygen (mg/L)	> 4.0	5.5 ± 0.2
Ammonia (ppm)	< 0.5	0.30 ± 0.03
Nitrite (ppm)	< 0.5	0.10 ± 0.01
Nitrate (ppm)	< 40	25.0 ± 1.2
Hardness (ppm)	50–150	165 ± 5
Salinity (ppt)	0	0.20 ± 0.02
TDS (ppm)	Low preferred	250 ± 12

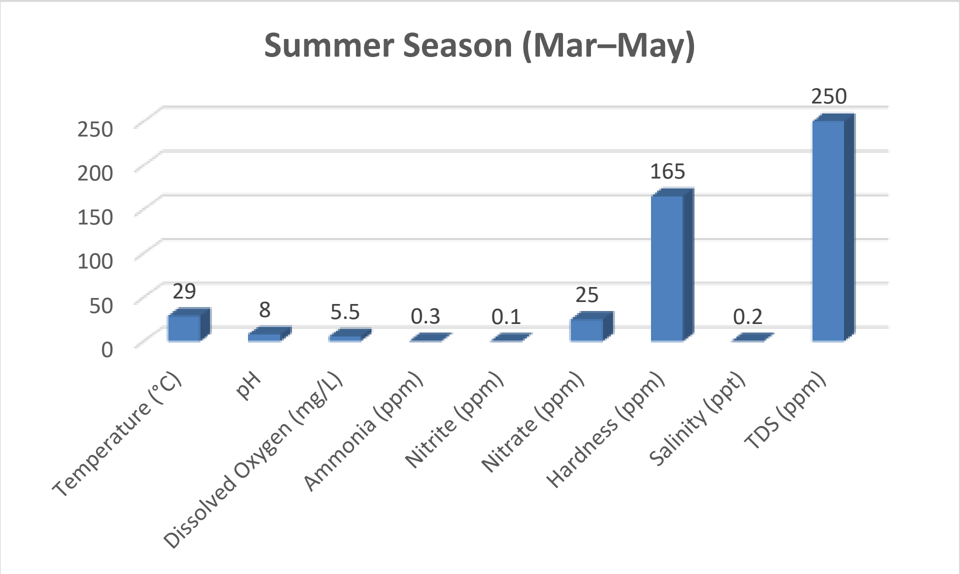

Figure 4.2 Summer Season Water Quality Parameters

The temperature was found to be suitable for spawn in summer season while higher pH, hardness and temperature placed physiological stress. Optimum reproducing success but less fry survival and deformities found in Gourami reared under these conditions.

Table 4.3 Monsoon Season Water Quality Parameters (Jun–Sep)

Parameter / Unit	Optimum Range	Monsoon
Temperature (°C)	23–29	25.0 ± 0.4
pH	6.0–7.5	7.6 ± 0.1
Dissolved Oxygen (mg/L)	> 4.0	6.0 ± 0.2
Ammonia (ppm)	< 0.5	0.25 ± 0.02
Nitrite (ppm)	< 0.5	0.10 ± 0.01
Nitrate (ppm)	< 40	32.5 ± 1.5
Hardness (ppm)	50–150	95 ± 4
Salinity (ppt)	0	0.15 ± 0.01
TDS (ppm)	Low preferred	400 ± 15

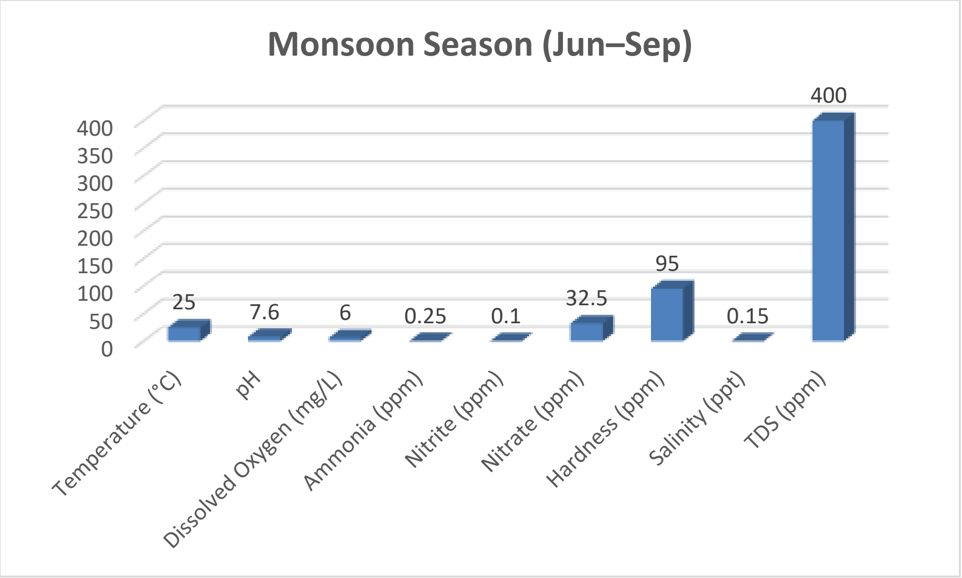

Figure 4.3 Monsoon Season Water Quality Parameters

Favourable temperature, dissolved oxygen and moderate hardness levels in the monsoon seasons favored the production of Gourami. Although the TDS levels were higher, the environmental conditions remained stable which facilitated with good spawning results, better hatching rate and fry survival rates.

4.2 Seasonal Breeding Performance

Quality of water was one factor and seasonal environmental changes another, which affected significantly the seasonal breeding performance of Gourami. Consequently, winter (low temperatures/low cold stress) precluded any breeding activity. Moderate breeding performance was observed in summer season but above temperature 30°C of summer induced physiological stress leading with respect to reduced fry survival at higher temperatures and higher deformity rates in summer season. The comparatively good spawning success, the high hatching percentage, and the higher larval survival observed during the monsoon season was attributed to the favourable temperature which served as spawning trigger.

Figure 4.1 Newly Hatched Gourami Larvae

Table 4.2 Seasonal Breeding Performance of Gourami

Breeding Metric	Winter	Summer	Monsoon
Spawning Success	No Breeding	Moderate	High
Total Eggs Laid	NA	1000 ± 45	1250 ± 40
Hatching Rate (%)	NA	50 ± 2.1	70 ± 2.5
Survival Rate at 7 Days (%)	NA	10 ± 1.2	27.5 ± 1.5
Survival Rate at 30 Days (%)	NA	2.5 ± 0.5	20 ± 1.2
Deformities Observed (%)	NA	32.5 ± 1.8	12.5 ± 1.0

4.3 Influence of Temperature on Breeding Performance

The temperature was one of the most influential environmental parameters that was known to affect the breeding success in Gourami. Complete absence of spawning activity in the mean winter temperature of 21°C which is below the optimum range of breeding (23-29°C).

There were stress conditions for breeding during temperatures above 30°C during the summer when the mean temperature was 29°C. The relatively stable temperature during monsoon season (25°C) promoted spawning and larval growth.

Table 4.3 Comparative Effect of Temperature on Breeding

Season	Mean Temperature (°C)	Breeding Response
Winter	21	No breeding due to cold stress
Summer	29	Moderate breeding with heat stress
Monsoon	25	High spawning activity

4.4 Influence of TDS on Breeding Performance

Breeding performance was significantly affected by changes in the Total Dissolved Solids (TDS) concentration throughout the seasons. The TDS levels in summer were low, which helped in spawning activity, while in monsoon season it was high that affected fry survival to some degree.

Table 4.4 Comparative TDS and Breeding Performance

Season	**TDS (ppm)**	**Hatching Rate (%)**	**Survival at 30 Days (%)**
Winter	**300**	**NA**	**NA**
Summer	**250**	**50**	**2.5**
Monsoon	**400**	**70**	**20**

The result suggests that the various moderate TDS levels were suitable for Gourami spawning and hatching.

4.5 Comparative Survival and Deformity Analysis

The seasonality in the larval survival and deformity percentage were attributed to environmental stress conditions. It was observed that high temperature and changing water quality during summer season affected survival and increased deformities while comparatively good quality of fry was seen during monsoon season.

Table 4.5 Seasonal Survival and Deformities of Fry

Season	Survival at 7 Days (%)	Survival at 30 Days (%)	Deformities Observed (%)
Winter	NA	NA	NA
Summer	10	2.5	32.5
Monsoon	27.5	20	12.5

The higher deformity percentage during summer indicates adverse effects of heat stress on embryonic and larval development.

Figure 4.2 Normal and Deformed Fry Comparison

4.6 Comparative Analysis with Previous Research Studies

Results from this research are similar to the previous research on ornamental fish breeding which indicated that keeping constant temperature levels, moderate level of TDS and appropriate dissolved oxygen is necessary to achieve successful spawn and fry rearing.

Table 4.6 Comparison of Present Findings with Previous Studies

Parameter	Present Study	Earlier Research Findings
Optimum Temperature	25–29°C	24–30°C
Suitable pH Range	7.0–8.0	6.5–8.0
Preferred TDS Range	200–300 ppm	Low to moderate TDS favorable
Highest Hatching Rate	70%	55–85%
Highest Fry Survival	20%	20–40%

In the present investigation, it has been confirmed that temperature and TDS plays an important influence in breeding efficiency of the Gourami, in the hatching and fry survival under captive ornamental fish culture system. (Degani, 1989)

DISCUSSION

It is clear from the following results of the breeding performance of three-spot gourami, *Trichogaster trichopterus*, that the reproductive success is greatly influenced by water quality fluctuations that occurred during the breeding seasons especially temperature and Total Dissolved Solids (TDS). All spawning was found to be arrested completely during winter period because the mean temperature recorded (21.0 ± 0.5 °C) fell outside the optimum breeding range (23 – 29 °C) despite the favourable dissolved oxygen (7.0 ± 0.3 mg/L), very low ammonia (0.15 ± 0.02 ppm) and moderate temperature dissolved salt (TDS) (300 ± 10 ppm). This means that temperature is the major limiting factor that overrode other appropriate factors. In contrast, summer exhibited a mean temperature of 29.0 ± 0.6 °C, pH 8.0 ± 0.1, hardness 165 ± 5 ppm, and lower TDS (250 ± 12 ppm), which initiated spawning with 1000 ± 45 eggs laid and 50 ± 2.1% hatching. Higher fry mortalities were found (10% at 7 days; 2.5% at 30 days) and a greater deformity rate (32.5 ± 1.8%) under elevated temperature stress and increased hardness, however (Pollak et al., 1978)

In this case most favourable breeding season occurred in the monsoon season which included the following parameters of a stable temperature of 25.0 ± 0.4 °C, a pH of 7.6 ± 0.1, hardness of 95 ± 4 ppm and high TDS of 400 ± 15 ppm. Spawning performance was more than vastly improved with 1250 ± 40 eggs, 70 ± 2.5% hatch and numbers were significantly lower for deformities (12.5 ± 1.0%) and numbers were much higher for survival (27.5% to 7 days and 20% to 30 days). The optimum temperature and moderate hardness during monsoon raised TDS but it did not seem to cause much osmotic stress on the embryo which helps in the development and viability of larvae.(Parada-Guevara et al., 2012)

These observations suggest that moderate TDS (200-300 ppm) is, generally speaking, the optimal range, but the relative stability of the water temperature (25 °C) and hardness (under 100 ppm), are more telling for successful gourami breeding. The results show that there is a synergy between the water chemistry parameters and thermal parameters and that maintaining optimum water temperatures plays an important role in breeding success, fry survival and even in producing total fry production in ornamental fish farming operations.(Webb, 2007)

5. CONCLUSION

The current research has demonstrated that both water temperature and Total Dissolved Solids (TDS) are performing significantly in breeding success of three-spot gourami, *Trichogaster trichopterus* and remaining as the crucial water quality parameters in the study. Complete breeding failure, over a range of otherwise good water parameters, under the conditions of a mean temperature of 21°C, was witnessed during the winter season. The higher beyond optimal heat stress, hardness, and pH had detrimental effects on fry survival and deformities, respectively, were evident for breeding initiated at 29°C and above 250 ppm TDS. The best breeding time was in the monsoon season when the temperature was stable at 25°C, hardness was moderate and dissolved oxygen was good with the highest spawning success having 70% with hatching success of 70% and a higher larval survival rate at 20% at 30 days with lesser deformities. Compared to rural parts of the country TDS levels were relatively high during monsoon, due to the optimal hot environmental conditions and appropriate water chemistry, it was offset by promoting embryo and larval development. The present study strongly suggests the need to maintain the temperature within 25–29°C, moderate TDS (200–300 ppm if possible) and hardness less than 100 ppm to improve breeding efficiency of gourami in captive culture of ornamentals fish. Severe seasonal fluctuation in water quality parameters can cause considerable loss in spawning, fry production and fry survival. Water quality changes during the year can dramatically affect the spawning and fry production as well as fry survivability. The results offer practical recommendations for" ornamental fish producers using groundwater resources, and demonstrate the importance of implementing different water management plans throughout the breeding season for successful production.

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