Journal of Aquatic Biology & Fisheries | 2024 | 12(1) | pp. 37-40
ISSN 2321–340X
OPEN ACCESS
http://www.jabf.in/
University of Kerala, INDIA

Biosecure semi-intensive polyculture of Nile Tilapia and Striped Catfish in silpaulin lined pond: Growth performances and economics

Muneer A.* and Pramod Kiran R.B.

Dept. of Aquatic Biology and Fisheries, University of Kerala, Karyavattom Campus, Trivandrum – 695581, India
**E.mail: akmuneer93@gmail.com*

ABSTRACT

Polyculture of Nile Tilapia, *Oreochromis niloticus* (Linnaeus, 1758) and Striped Catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878) were carried out in the Silpaulin lined ponds (7m x 5m x 1.5m) carrying approximately 40 tons of water. Two hundred and fifty numbers of GIFT Tilapia (initial length and weight of 16.09±0.13cm and 88.9±2.63g) and hundred numbers. of striped catfish (initial length and weight of 19.98±0.32cm and 95.25±3.02g) were stocked in the pond for assessing their polyculture potential in silpaulin lined ponds. Tilapia gained a mean length of 6.41 cm (mean final length 22.5±0.23cm) and mean weight of 152.14 g (mean final weight 241.04±9.77g), while striped catfish gained a length of 13.83 cm (to 33.8±1.44cm) and weight of 293.93g (mean final length 389.18±57.61g). The FCR of the total system was calculated as 2.25 and FCE as 0.44. The estimated average growth rate of Nile tilapia was 1.62g/day and striped catfish was 3.13g/day. The specific growth rates of Nile tilapia and striped catfish were estimated as 1.06% and 1.50%, respectively. Of the 250 *O. niloticus* stocked 231 (92.4%) survived, while 98% of *P. hypophthalmus* stocked could be harvested. The economics of the polyculture was calculated and the total revenue was estimated. The net profit margin against recurring cost was calculated as 49.25%.

ARTICLE HISTORY

Received on: 29-01-2024
Revised on: 20-07-2024
Accepted on: 23-07-2024

KEYWORDS

GIFT, Basa,
Tilapia culture,
Sustainable aquaculture

1. Introduction

Exotic fishes play a major role in poverty alleviation and employment generation through aquaculture despite the ecological risks involved in farming. Though pond culture is a common practice (Dey et al., 2005), promoting exotic fish culture must be carried out with caution to prevent ecological impacts. The state of Kerala is unique in its diverse water bodies with 44 rivers, 30 reservoirs and 0.25 lakh ha of ponds and tanks along with flora and fauna (Harikumar and Rajendran, 2007). Hence, the culture of exotic fish in Kerala should be carried out in areas far from open water sources. Though monoculture is the commonly followed strategy, polyculture reduces the farmers' risk even if one of the species fails (Stickney, 2000). Indian polyculture techniques conventionally focus on carps, including the Indian major carps and exotic Chinese carps (Mohan Dey et al., 2005). Tilapia and catfishes are also included in this system in varying proportions (Azad et al., 2004). Tilapia is an African native group of fish with aquaculture importance in more than 100 countries (Fitzsimmons, 2016). Among these, the GIFT variety of Nile tilapia, *Oreochromis niloticus* (Linnaeus, 1758) (Perciformes, Cichlidae), is the most accepted species for aquaculture (WorldFish, 2015). Catfish is the common name of fishes belonging to the Order Siluriformes. Pangasiidae is an important family of cultured catfishes in different parts of the world, especially Southeast Asian countries (Roberts and Vidthayanon, 1991). Striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878), commonly known as 'basa' is a fish belonging to the family Pangasiidae, which is native to Thailand and Vietnam and cultured in tropical countries, mainly in Asia (Griffith *et al.,* 2010). Striped catfish have unique white flesh and high protein content and are often called 'aquatic pigs' due to their specific qualities. *P. hypophthalmus* from Thailand was introduced, probably in 1997 from Bangladesh for monoculture rather than polyculture (Mukai, 2011), first in West Bengal and later on a larger scale in Andhra Pradesh and Orissa, and has since then developed into a network of farms and hatcheries (Singh and Lakra, 2012).

The present study describes the polyculture of Nile Tilapia, *O. niloticus* and, striped catfish, *P. hypophthalmus* in a silpaulin lined pond and the assessment of growth and survival of fishes in the system. Various management aspects involved in a semi-intensive system were also monitored during the study. An economic analysis of the operations was also carried out to evaluate its profitability. The data generated from the study will be useful in developing standard protocols for the culture of these species.

2. Materials and Methods

The culture trial was conducted on a Farm at Kariyavattom (8°33'50.3" N 76°53'46.3" E) in Thiruvananthapuram District. The analysis of samples was carried out in the Department of Aquatic Biology and Fisheries, University of Kerala. Culture Pond was a rectangular earthen pond lined with Silpaulin, a quality tarpaulin material for retaining water. It was 7 x 5 x 1.5 (m) and carried approximately 40000 L of water. The pond was pumped from a nearby creek. About 10 - 20% of water was replaced once every ten days. Chemical fertilizers, probiotics, antibiotics, etc., were not used during the culture period. Two hundred and fifty seeds of the *O. niloticus* (mean initial length and weight of 16.09±0.13cm and 88.9±2.63g) and 100 numbers of *P. hypophthalmus* (mean initial length and weight of 19.975±0.32cm and 95.25±3.02g) were procured from reputed fish hatchery/suppliers in Kerala, transported to

the farm in oxygen-filled polythene bags and stocking was carried out in the cool hours of the morning after sufficient acclimatization. *Godrej Shakti* premium floating fish feed manufactured by Godrej Agrovet Ltd. was used to feed the fish. Feed was provided @10% of the body weight in the initial month and was gradually reduced to 5% in the subsequent months. The weight data collected fortnightly was used to calculate the feed requirement. The fishes were also inspected for external parasites and other pathogenic diseases. Weekly water samples were collected for analysis of Dissolved Oxygen (DO), pH, Carbon dioxide (CO_2), alkalinity, hardness, nitrate, ammonia and phosphate following American Public Health Association (1998).

Proximate composition of flesh of fishes, *P. hypophthalmus* and *O. niloticus* were carried out in the laboratory using standard methods. The length and weight data generated was used to establish the fishes' length-weight relationship and estimate various growth parameters using MS Excel. The feed conversion ratio (FCR) and the economics of the operation were also worked out.

3. Results and Discussion

The GIFT variety of Nile Tilapia grew to an average length of 22.5±0.23cm and average weight of 241.04±9.77g from harvest from April, 2016 to July, 2016. The gain in length for tilapia during the culture period was 6.41cm and the gain in weight was 152.14g. Striped catfish attained an average length of 33.8±1.44cm and a weight of 389.18±57.61g, with mean gain in length of 13.825cm and mean gain in weight of 293.93g in the four month long culture period.

The length-weight relation of the data obtained for *O. niloticus* has been worked out as $Log\ W = 2.817 + Log\ L_* - 3.316$. The 'b' value suggests a negative allometry for tilapia, a factor which is widely reported due to the shape of the species. The Correlation coefficient obtained was 0.946. The length-weight relation for *P. hypophthalmus* was $Log\ W = 2.596 + Log\ L_* - 3.227$. The 'b' value suggests a negative allometry for Striped catfish, probably due to the shape of the species. The Correlation coefficient obtained was 0.971. The final survival of the fishes was recorded as 231 (92.4%) survived for *O. nloticus* and 98 (98%) for *P. hypophthalmus*. The survival data indicate that excellent culture conditions existed in the pond.

Based on FishBase (Froese and Pauly, 2017), the 'b' values of *O. niloticus* and *P. hypophthalmus* expressed as 2.97 (2.93 - 3.01) and 3.06 (2.90 - 3.22) respectively.

3.1. Analysis of Growth

Average Daily Growth Rate for *O. niloticus* was estimated as 1.62g/day and the same for *P. hypophthalmus* was 3.13g/day. Specific Growth Rate (SGR) was estimated as 1.06% for *O. niloticus* and 1.50% for *P. hypophthalmus*. Tran-Duy et al. (2008) estimated the SGR of *O. niloticus* to be 1.63% in big fishes, and Rahman et al. (2008) reported 1.16 - 1.5% in different trials. Shoko et al. (2016) estimates an SGR of 1.37 in Nile tilapia polycultured with African sharptooth catfish (*Clarias gariepinus*) in a medium density culture system. Hung et al. (1998) computed the SGR of *P. hypophthalmus* as 2.65 - 3.37% in different trials of day feeding groups.

FCR of the total system was estimated as 2.26, and FCE was 0.44. According to Masser (2017), the overall FCR of Nile tilapia and Channel catfish (*Ictalurus punctatus*) was 2.2 - 2.3 in different ratios. Protein Efficiency Ratio (PER) of the total system was 2.22. The proximate compositions of the cultured fishes were estimated (Table 1), and it was observed that the fishes maintained a nutritional composition similar to that of previous reports.

3.2. Water Quality Monitoring

The results of the monthly water quality monitoring are presented in Table 2. Dissolved oxygen is the most critical water quality parameter as lower values during the early morning hours may lead to the mortality of the fishes. Dissolved oxygen values were monitored five times a day once in a month to monitor the fluctuations. The results of fluctuations in DO are presented in Fig. 3. The results of the water quality monitoring showed that all the parameters remained within the optimum range for fish culture throughout the culture period. The relatively lower DO levels in the early morning samples recorded in the morning were corrected by reducing the night feed ration and adding freshwater in the early morning.

3.3. Economic Analysis

The available expenses and income were used for preliminary economic analysis (Table 3). The culture period under consideration was only a 5 months period, including the time taken for pond construction. This enables the possibility of 2 to 3 culture cycles in a year

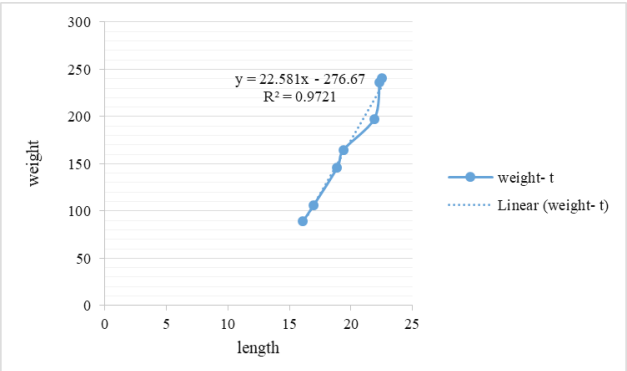

Fig. 1. Length -weight relationship of Nile Tilapia reared in the system

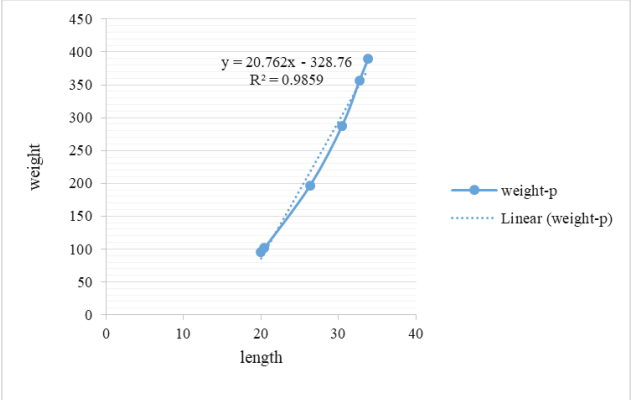

Fig. 2. Length -weight relationship of Nile Tilapia reared in the system

Table 1. Proximate composition of *O. niloticus* and *P. hypophthalmus* in the present study and recent published reports

Parameters	*O. niloticus*			*P. hypophthalmus*		
	Present study	Job et al., 2015	Flick, Jr., 2006	Present study	Begum et al., 2012	Debbarma et al., 2013
Moisture (%)	72.7	80.9	75.3	76.6	78.29	78.81
Crude Protein (%)	18.2	17.4	20.3	15.7	12.78	15.86
Fat (%)	5.9	0.57	5.7	5.6	16.55	2.97
Ash (%)	3.2	1.74	2.3	2.1	1.78	0.43

Table 2. The results of the monthly average of water quality analysis

Parameters	Month 1	Month 2	Month 3	Month 4
DO (mg/l)	5.3	5.1	4.9	4.8
pH	7.5-8	7.5-8.5	7.5-9	7.5-8.5
Transparency (cm)	25	23.5	14.2	17.6
CO_2 (mg/l)	8.8	11.2	5.5	5.5
Total Hardness (mg/l)	80	100	105	90
Ammonia (µg/l)	0.008	0.008	0.36	0.33
Nitrate (µg/l)	Bdl*	0.119	2.04	1.64
Phosphate (ppm)	0.03	0.05	0.05	0.06

* Below detectable level

depending on the availability of water and optimization of culture activities. The silpaulin lining is expected to remain without damage for at least two years (4-6 production cycles). The economic return is attractive considering the very small area of land used for the culture. All the fish sales were at the farm gate per customer's demand, indicating the potential for marketing farm fresh fish in the region. However, it is worth mentioning that the prices realized for the cultured species are much higher than the current market prices elsewhere. This can be attributed to the consumer preference for fresh farm fish (freshly caught and supplied when live) and the lack of competition in the locality.

Based on the studies of Dasgupta and Bryant (2017) about the economics of tilapia pond culture, they got 2,000 kg from 0.4 ha with the economics of US $ 4.45/kg. Shoko et al. (2016) reported a significant difference in the economics of monoculture and polyculture of Nile Tilapia and African sharptooth catfish (*Clarias gariepinus*). According to his report, the profit against recurring costs of monoculture and polyculture was 8.15 and 239.75 US$, respectively.

Table 3. Economic analysis of polyculture of *O. niloticus* and *P. hypophthalmus*

	EXPENDITURE		Cost in INR
1.	**Fixed Cost**		
	Pond Construction		Rs. 5000/-
	Pond lining		Rs. 4100/-
	Cover Net		Rs. 750/-
	Total Fixed Cost		**Rs. 9850/-**
2.	**Recurring Expenses**		
	Cost of Seed		
	(i)	GIFT- *O. niloticus* @ Rs. 6 per seed for 250 nos.	Rs. 1500/-
	(ii)	*P. hypophthalmus* @ Rs. 6 per seed for 100 nos.	Rs. 600/-
	Cost of feed		
	(i)	Size 1 (3.5 kg @ Rs. 90/kg)	Rs. 315/-
	(ii)	Size 2 (12 kg @ Rs. 60/kg)	Rs. 720/-
	(iii)	Size 3 (137 kg @ Rs. 45/kg)	Rs. 6165/-
3	Miscellaneous Expenditure		Rs. 2500/-
	Total Recurring Cost		**Rs. 11800/-**
	REVENUE		
1.	Sale of Nile Tilapia @ Rs. 250/kg for 55 kg		Rs. 13750
2.	Sale of striped catfish @ Rs. 250/kg for 38 kg		Rs. 9500
	Total Revenue		Rs. 23250/-
	Profit against Recurring cost		**Rs. 11450/-**

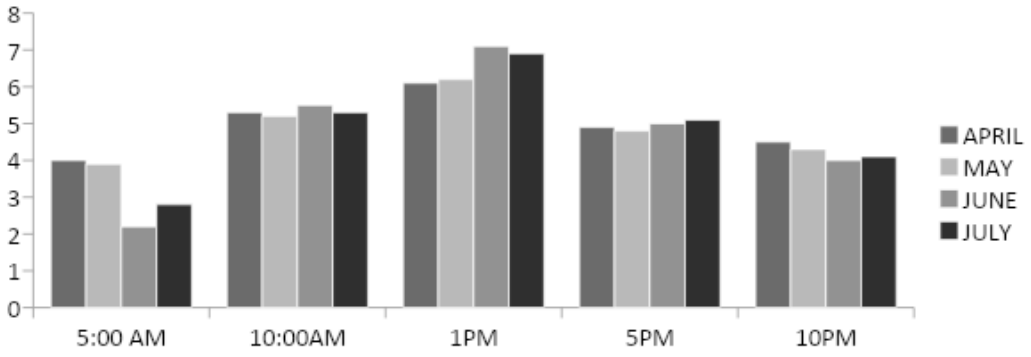

Fig. 3. Fluctuation in DO concentration during the culture of *O. niloticus* and *P. hypophthalmus* in silpaulin lined pond

4. Conclusion

The study describes the polyculture of Nile Tilapia and Pangasius in Silpaulin lined pond, a common grouping of exotic fishes cultured across India. The assessment of growth and economics of the system proved it to be a sustainable fish culture model, in which the lining offers biosecurity with a minimum feasible investment. Also, the semi-intensive culture practices were made into a minimum investment in the cost of electricity. The 5:2 ratio of the Tilapia and striped catfish is also considerable in their behaviour. Considering the commercial value of the fish cultured, the semi-intensive practice with the cheapest biosecurity measures for the culture of exotic aquatic candidates will ensure biosecurity and profitability.

Acknowledgment

Authors gratefully acknowledge Mr. Anu A. S., Mr. Shiraz Ansari, S., Mr. Bijukumar for providing the work space and support.

5. References

Ali, H., Haque, M. M. & Belton, B. 2013. Striped catfish (*Pangasianodon hypophthalmus*, Sauvage, 1878) aquaculture in Bangladesh: An overview. Aquaculture Research, 44(6):950–965. https://doi.org/10.1111/j.1365-2109.2012.03101.x

American Public Health Association 1998. Standard methods for the examination of water and wastewater, 20th Editions. Washington DC, USA.

Azad, M.A. K., Rahman, M. R., Rahman, Z., Kader, M. A., Haque, M. M. & Alam, M. J. 2004. Polyculture of Carp, Tilapia and Pangas Using Low Cost Inputs. Pakistan Journal of Biological Sciences, 7: 1918-1926. https://doi.org/10.3923/pjbs.2004.1918.1926

Begum, M., Akter, T. and Minar, M.H. 2012. Analysis of the proximate composition of domesticated stock of pangas (*Pangasianodon hypophthalmus*) in laboratory condition. Journal of Environmental Science and Natural Resources, 5(1), pp.69-74. https://doi.org/10.3329/jesnr.v5i1.11555

Charo-Karisa, H., Komen, H., Rezk, M.A., Ponzoni, R.W. & van Arendonk, J.A. & Bovenhuis, H. 2006. Heritability estimates and response to selection for growth of Nile tilapia (*Oreochromis niloticus*) in low-input earthen ponds. Aquaculture, 261(2), pp.479-486. https://doi.org/10.1016/j.aquaculture.2006.07.007

Dasgupta, S. & Bryant, R. C. 2017. The economics of small-scale tilapia aquaculture in the United States. In: Perschbacher, P. W. and Stickney, R. R. Tilapia in Intensive Co-culture, Wiley Blackwell, UK. 306-318pp.

Debbarma, S. & Majumdar, R. K. 2013. Biochemical and Organoleptic Changes of Surimi from the Thai Pangas (*Pangasianodon hypophthalmus*) During Frozen Storage. Indian Journal of Fisheries. 60(4). 99-106.

Dey, M. M. , Paraguas, F. J., Srichantuk , N. Xinhua, Y. , Bhatta, R. & Dung, L. T. C. 2005. Technical Efficiency of Freshwater Pond Polyculture Production in Selected Asian Countries: Estimation and Implication. *Aquaculture Economics & Management*, 9:1-2, 39-63 p.

Fitzsimmons, K. M. 2016. Global Tilapia Market update 2015. In: World Aquaculture Society 2016, Las Vegas. https://doi.org/10.13140/RG.2.1.2848.9448

Flick, G. J. Jr. 2006. Tilapia composition: part 1. Proximate analysis, factors affecting fatty acid composition. Global Aquaculture Advocate pp. 24-25.

Froese, R. & Pauly, D. (Eds.) 2017. FishBase. World Wide Web electronic publication. www.fishbase.org

Griffith, D., Khanh, P.V. & Trong, T.Q. 2010. Cultured Aquatic Species Information Programme: *Pangasius hypothalamus* (Sauvage, 1878). Fisheries & Aquaculture Department, FAO, Rome.

Harikumar, G. & Rajendran, G. 2007. An Over View of Kerala Fisheries - with Particular Emphasis on Aquaculture. IFP Souvenir, 37pp.

Hung, L. T., Tuan, N. A. & Lazard, J. 1998 Effects of frequency and period of feeding on growth and feed Utilisation in two Asian catfishes, *Pangasius bocourti* (sauvage, 1880) and *Pangasius hypophthalmus* (sauvage, 1878) In: Legendre, M. and Pariselle, A. (Eds.) Proceedings of the mid-term meeting of the Catfish Asia project, cantho, Vietnam. 157-174pp.

Job, B. E., Antai1, E. E., Inyang-Etoh, A. P., Otogo G. A. & Ezekiel, H. S. 2015. Proximate Composition and Mineral Contents of Cultured and Wild Tilapia (*Oreochromis Niloticus*) (Pisces: Cichlidae) (Linnaeus, 1758)., Pakistan Journal of Nutrition 14 (4): 195-200. https://doi.org/10.3923/pjn.2015.195.200

Masser, M. 2017. Tilapia Co-culture in Cages and In-pond Raceways. In: Perschbacher, P. W. and Stickney, R. R. Tilapia in Intensive Co-culture, Wiley Blackwell, UK. 148-155 pp.

Mohan Dey, M., Javien Paraguas, F., Srichantuk, N., Xinhua, Y., Bhatta, R. & Thi Chau Dung, L. 2005. Technical efficiency of freshwater pond polyculture production in selected Asian countries: estimation and implication. Aquaculture Economics & Management, 9(1-2), pp.39-63. https://doi.org/10.1080/13657300590961528

Mukai, Y. 2011. High survival rates of sutchi catfish, *Pangasianodon hypophthalmus*, larvae reared under dark conditions. Journal of Fisheries and Aquatic Science, 6(3), p.285. https://doi.org/10.3923/jfas.2011.285.290

Rahman, M.M., Verdegem, M. & Wahab, M.A. 2008. Effects of tilapia (Oreochromis niloticus L.) stocking and artificial feeding on water quality and production in rohu–common carp bi-culture ponds. Aquaculture Research, 39(15), pp.1579-1587. https://doi.org/10.1111/j.1365-2109.2008.02029.x

Roberts, T.R. and Vidthayanon, C. 1991. Systematic revision of the Asian catfish family Pangasiidae, with biological observations and descriptions of three new species. Proceedings of the Academy of Natural Sciences of Philadelphia, pp.97-143

Shoko, A.P., Limbu, S.M., Mrosso, H.D.J., Mkenda, A.F. & Mgaya, Y.D. 2016. Effect of stocking density on growth, production and economic benefits of mixed sex N ile tilapia (O reochromis niloticus) and A frican sharptooth catfish (C larias gariepinus) in polyculture and monoculture. Aquaculture Research, 47(1), pp.36-50 https://doi.org/10.1111/are.12463

Singh, A.K. & Lakra, W.S. 2012. Culture of *Pangasianodon hypophthalmus* into India: impacts and present scenario. Pakistan Journal of Biological Sciences, 15(1), p.19.

Stickney, R.R. 2000. Polyculture. in R.R. Stickney, (eds.) Encyclopedia of Aquaculture. John Wiley and Sons, New York. 658-660, ISBN: 978-0-471-29101-5.

Tran-Duy, A., Schrama, J.W., van Dam, A.A. & Verreth, J.A. 2008. Effects of oxygen concentration and body weight on maximum feed intake, growth and hematological parameters of Nile tilapia, *Oreochromis niloticus*. Aquaculture, 275(1-4), pp.152-162 https://doi.org/10.1016/j.aquaculture.2007.12.024

WorldFish 2015. Genetically Improved Farmed Tilapia (GIFT). WorldFish (www.worldfishcenter.org).