

Cage culture of *Oreochromis Mossambicus* (Tilapia) in back water of river Godavari, Nanded, Maharashtra India

Abstract

Cage culture practice is an important technology for culture of finfish and non fin fish organisms. It is gaining importance day by day. This was a first attempt to check the suitability of cage culture in back water of Godavari. This water remains present up to March and April; hence this experiment was carried out from October 2012 to April 2013 (180 days) at Dhangar Takli on the bank of river Godavari. Results showed that *Oreochromis mossambicus* fish was useful fish for cage culture practice in this area. Although, the Monosex culture of *Oreochromis mossambicus* may be more applicable because this fish is prolific breeder. If we alter the breeding of fish then this will may help to increase the growth of the fish. *Oreochromis mossambicus* commonly called as freshwater pomfret. People of this area consume this fish is in high quantity; hence for high production this cage culture method may be helpful.

Keywords: cage culture, Godavari, tilapia, backwater, *Oreochromis Mossambicus*

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Introduction

Culture of fresh water fishes in square or round boxes along with artificial feeding, management for the more production is called cage culture. This practice is suitable for the backwater because the water is present throughout the year, as this water is reserved for drinking, irrigation purpose. Fishermen of that particular area may use this water for culture fishery. This technology is helpful to focus on culture fisheries, in the region of Marathwada fishermen busy in only capture fishery. If we done only capture fishery then the fish resources get decline day by day. Fish production in cages became highly popular among the small or limited resource farmers who are looking for alternatives to traditional agricultural crops. Cage culture is advantageous for farmers as it offers a chance to maximum utilization of existing water resources. Therefore, the farmers do not have to invest on accumulating water. Cage aquaculture has certain advantages over other aquaculture systems that are potentially important in terms of uptake by rural poor and landless people.¹ Production of fish from Inland capture fisheries is on declining trend in the last few years because of several man made activities like, habitat destruction, pollution, climate change etc. hence reservoir needs immediate attention for development of fisheries in a scientific and sustainable manner to augment the fish production for the population of India.²

The Cage culture practice is important to the landless people as they can use communal water bodies for the culture of fishes in cages. It is better way to obtain nutrition and income from the fish production. This method is also useful to eradicate the common problem i.e. multiple ownership. Anyone can use this technology, ownership is easy, means the owners of the cages are the real proprietor of the cage. Fishes which are culture in the cages are not escaping from the net, it also provide feeding ring at the top for feeding purpose. It is also useful to protect the culture fishes from the other predatory fishes. Harvesting mechanism is simple and easy as compare to capture fishery. This will also helps to conservation of endangered fishes. When the fishermen release the fingerlings to any pond, the

mortality is the big issue. By using this technology, we can reduce the percentage of mortality in fingerlings. We can save them from predatory fishes that are already present in water body, if we culture in cages the problem of predatory fishes is solved. The management of fishes is easily done in cage culture practice.

This study was carried out for the first time in Marathwada region of Maharashtra state. The experiment was undertaken to check the suitability of *Oreochromis mossambicus* in cage culture in the backwater of river Godavari. *Oreochromis mossambicus*, Tilapia has good potential for the enhancement of production in the fishery sector of India but considerable research is required to adopt different techniques of tilapia culture that are practiced in other countries. The fish is actually cultured in diverse systems in inland rural areas, in areas around large cities, in wastewater ponds and even in brackish water ponds in coastal areas. The advantages of such culture are widely recognized for rural food supply. It can provide an opportunity to balance the use of supplementary feeding in correlation with the natural food availability and hence reduce the production cost. Semi-intensive and intensive cage cultures are also viable in a range of circumstances. The management flexibility of close culture systems can be achieved in open water through such cage culture method.³

Advantage of cage culture

The rearing and raising of fishes in cages is gaining importance all over the world because of its increasing technical, ecological, social and economic advantages over capture fisheries and conventional aquaculture.

Advantages of cage culture in Marathwada are as follows:

- Back water of rivers present in Marathwada can be used for cage culture practice.
- This method of culture is useful to poor and needy person who are lives near to shore the river.
- If proper artificial feeding is done then the chances of high production from cage culture is more.

- d. Management of fishes is very easy.
- e. We can culture more than one crop in a year, this cannot possible in pond, reservoirs etc.
- f. If we culture Monosex of tilapia then the continuous breeding will stop and more growth will observe
- g. We can check the proper feeding mechanism in cage culture technology which cannot possible in pond or any other culture system because of vast area of water body.
- h. The cages were use again and again by using some minor repairing so the investment is also few.
- i. The locally available material may be used for the construction of cages and it will help to the fishermen community to employment.
- j. So cage culture technology not only helpful to culture of fishes but also by constructing the cages gives double income to the fishermen.

By considering the importance of Cage culture, this experiment was set up for the first time in Marathwada region because in this area plenty of water resources are available, that can be useful for this technology. If this cage culture technology will spread among the fishermen, fish farmers and entrepreneur related with fishery sector then this will helpful for increasing their income. Hence this work was carried out to check the suitability of *Oreochromis mossambicus* in cage culture from October 2012 to April 2013 at Dhangar Takli, a village situated on river Godavari.

Materials and methods

The back water of river Godavari is spread up to 40KM from Vishnupuri Project, Dhangar Takli situated on bank of river Godavari 19°7'12"N 77°3'28"E was selected as a study area.

Fabrication of cages

For the experiment fabrication of cages was important hence cages were fabricated from strong, durable, and non-toxic iron material with suitable size mesh. This material was easily available in any local market.

Cage materials

The 6' X 4' X 4' sized cages were used for the experiment. They were kept in submerged condition as the back water level decreases day by day because the farmers of this area used this water for their farm. The good qualities of iron square pipes were used for the frame. The frames of cages were prepared by gas welding. . The small mesh size was selected for easy circulation of water and to avoiding the escape of fingerlings from the cages. For the artificial feeding and management of fishes a feeding ring was prepared on the top of cages.

The cages were constructed by using the mesh to all sides except the bottom, by using the binding wire the mesh sheet was fixed to the frame. The galvanized sheet was used to the bottom of cages. Painting was done by using red oxide and sky blue oil paint.

Oreochromis mossambicus (Fresh water Pomfret)-Bottom feeder and Omnivorous fish was elected for the experiment.

Stocking of fish

Fingerlings of *Oreochromis mossambicus* collected from Mr. Parbatkumar Fish farmer from Ahmadpur, Dist. Latur. Fingerlings

were conditioned and brought in oxygenated polythene bag. Before stocking, length and weight of individual fish was measured and kept in different sets, one set with artificial food and second set was without artificial food i.e. with natural food. The stocking density was 100 fingerling/72 cubic foot.

Feeding

Fish was fed with commercial pelleted feed brought from Krishi Vigyan Kendra, Karda Tq. Risod Dist. Washim, as per their body weight i. e. 5% of their body weight, in the morning hours at 7:00 am every day.

Cage management

Cage management is one of the most important tasks in cage culture. Hence cages were cleaned regularly before feeding, to remove dead fishes, uneaten food etc. to keep the environment good for fish. The cages were lifted partially from water every 8 days before feeding, to check the damage and remove algal blooms.

Culture period

Fingerling of *Oreochromis mossambicus* was cultured in cages for 180 days.

Water quality parameters

Water is the most vital resource for all kinds of life on this planet. This resource is adversely affected qualitatively and quantitatively by human activities.⁴ During the study important limnological parameters such as Temperature, pH, Transparency, Total alkalinity, Dissolved Oxygen (DO), Free Carbon dioxide (CO₂), Chloride, Hardness, Calcium, Magnesium, and Productivity were analyzed by using standard method as suggested in.⁵

Statistical analysis

The data were expressed in terms of mean±standard error. All data were subjected to one-way ANOVA. This analysis was done by using Graph pad Prism Software 6.

Organization of workshop

The cage culture technology is not known in this area; hence for popularization one day workshop was organized for the fish farmers, businessman, teacher's researchers and students so that activity of fish culture will spread.

Results

The growth performance of *Oreochromis mossambicus*, in natural and artificial feeding cages in terms of final weight, weight gain percentage, specific growth rate (SGR %), Daily growth rate (DGR), survival rate ,total production and physico chemical parameters were shown in table No.1,2 and 3.

Mean weight

The mean initial length of *Oreochromis mossambicus* for I, II, III, IV, V and VI th months was 0.7, 4.0, 6.4, 8.4, 10.9 and 13.7cm respectively. Their mean final length was 4.0±0.38, 6.4±0.31, 8.4±0.28, 10.9±0.51, 13.7±0.65 and 15.8±0.56cm for six months respectively. The mean final weight of natural feed cage was 3.83±0.47, 6.20±0.35, 8.86±0.94, 15.69±1.48, 37.40±7.21 and 64.65±8.32gm for I, II, III, IV, V and VI the months respectively.

In artificial feeding cage, the mean initial length was 0.8, 5.7, 7.2, 9.4, 12.5 and 14.8 cm, their mean final length was 5.7 ± 0.45 , 7.2 ± 0.41 , 9.4 ± 0.67 , 12.5 ± 0.59 , 14.8 ± 0.51 and 19.3 ± 0.80 cm in I, II, III, IV, V and VI th months respectively. Their final weight was 6.06 ± 1.54 , 7.60 ± 1.53 , 13.07 ± 2.35 , 24.13 ± 3.17 , 69.38 ± 9.48 and 148.84 ± 10.31 gm recorded in I, II, III, IV, V and VI the months respectively. The mean weight of natural feeding cage was 64.65 ± 8.32 gm and in artificial feeding cage, *Oreochromis mossambicus* attained 148.84 ± 10.31 gm.

Weight gain %

The weight gain percentage of *Oreochromis mossambicus* was 155.3, 61.87, 42.90, 77.08, 138.3 and 72.86% in natural feeding

cage. In artificial feeding cage the percentage of weight gain was 304, 25.41, 71.97, 84.62, 187.5 and 114.5% in I, II, III, IV, V and VI th months respectively.

Specific growth rates (SGR)

The specific growth rates (SGR) with treatments are given in Table 1 and Table 2. The treatments without artificial feeding attained the least mean SGR 7.7%/day/fish, 7.9%/day/fish, 8.8%/day/fish, 22.76%/day/fish, 72.36%/day/fish and 90.83%/day/fish, respectively.

In artificial feeding cage mean SGR 15.2%/day/fish, 5.13%/day/fish, 18.23%/day/fish, 36.86%/day/fish, 150.8%/day/fish and 264.8%/day/fish.

Table 1 Depicts the Growth analysis of 100 fingerling of *Oreochromis mossambicus* in natural feeding from October 2012 to April 2013 at Dhangar Takli (180 days)

Months	Initial length (cm)	Final length (cm)	Initial weight (gm)	Final weight (gm)	WG %	SGR	DGR	Mortality	Survival %
Oct-12	0.7		1.5					19	81
Nov-12	0.7	4.0 ± 0.38	1.5	3.83 ± 0.47	155.3	7.7	0.07	0	81
Dec-12	4	6.4 ± 0.31	3.83	6.20 ± 0.35	61.87	7.9	0.07	1	80
Jan-13	6.4	8.4 ± 0.28	6.2	8.86 ± 0.94	42.9	8.8	0.08	0	80
Feb-13	8.4	10.9 ± 0.51	8.86	15.69 ± 1.48	77.08	22.76	0.22	0	80
Mar-13	10.9	13.7 ± 0.65	15.69	37.40 ± 7.21	138.3	72.36	0.72	0	80
Apr-13	13.7	15.8 ± 0.56	37.4	64.65 ± 8.32	72.86	90.83	0.9	0	80
Total fish production(kg) = 5.1kg									

¹WG %, Weight gain percentage; 2SGR, Specific growth rate; 3DGR, Daily growth rate

Table 2 Depicts the Growth analysis of 100 fingerling of *Oreochromis mossambicus* in artificial feeding from October 2012 to April 2013 at Dhangar Takli (180 days)

Months	Initial length (cm)	Final length (cm)	Initial weight (gm)	Final weight (gm)	WG %	SGR	DGR	Mortality	Survival %
Oct-12	0.8		1.5					24	76
Nov-12	0.8	5.7 ± 0.45	1.5	6.06 ± 1.54	304	15.2	0.15	0	76
Dec-12	5.7	7.2 ± 0.41	6.06	7.60 ± 1.53	25.41	5.13	0.05	0	76
Jan-13	7.2	9.4 ± 0.67	7.6	13.07 ± 2.35	71.97	18.23	0.18	0	76
Feb-13	9.4	12.5 ± 0.59	13.07	24.13 ± 3.17	84.62	36.86	0.36	0	76
Mar-13	12.5	14.8 ± 0.51	24.13	69.38 ± 9.48	187.5	150.8	1.5	0	76
Apr-13	14.8	19.3 ± 0.80	69.38	148.84 ± 10.31	114.5	264.8	2.6	0	76
Total fish production(kg) = 11.3kg									

¹WG %, Weight gain percentage; 2SGR, Specific growth rate; 3DGR, Daily growth rate

The fish attained the maximum mean SGR 264.8 %/day/fish and the minimum mean SGR 5.13%/day/fish among the artificial feeding cage.

supplementary feeding cage daily growth rate was higher than natural feeding.

Daily growth rates (DGR)

Mean daily growth rate of *Oreochromis mossambicus* was calculated between natural feeding cage and supplementary cage. The mean daily growth rate of 0.07g/day, 0.07g/day, 0.08g/day, 0.22g/day, 0. 0.72 g/day and 0.90g/day were recorded in natural feeding cage.

A mean daily growth rate of 0.15g/day, 0.05g/day, 0.18g/day, 0.36g/day, 1.5g/day and 2.6g/day was recorded in the feeding cage. In

survival rate was 80% for natural feeding cage, whereas it was 76% recorded in Supplementary feeding cage during the culturing period.

Yield/total production

The total weight gained (yield) for each treatment per cage is depicted in Table 1 and Table 2. The weight increased was significantly

different with and without artificial feeding experiments. The total fish production of *Oreochromis mossambicus* in 180 days was more in artificial feeding cage as compare to natural feeding cage. 11.3kg recorded in artificial feeding cage and only 5.1kg recorded in natural feeding cage.

In study of *Oreochromis mossambicus* the t test Welch's correction for length was described in Figure 1 Welch' corrected t was 31.09 and $df=133.2$ and these results are significant. This calculation was carried out in 95% confidence interval i. e. 3.264 to 3.708. According to t test Welch's correction the length of *Oreochromis mossambicus* in natural feed caged fishes and artificial feed caged fishes were significant. F test was also carried out for compare variances and the values are $F=2.064$, $Df_n=75$ and $Df_d=79$ obtained. The p value for this data is 0.0017 and this study shows significant difference.

Table Analyzed	One-way ANOVA data
Column B	Artificial Feed
vs.	vs.
Column A	Natural Feed
Unpaired t test with Welch's correction	
P value	< 0.0001
P value summary	****
Significantly different? (P < 0.05)	Yes
One- or two-tailed P value?	Two-tailed
Welch-corrected t, df	t=31.09 df=133.2
How big is the difference?	
Mean ± SEM of column A	15.88 ± 0.06295, n=80
Mean ± SEM of column B	19.37 ± 0.09278, n=76
Difference between means	3.486 ± 0.1121
95% confidence interval	3.264 to 3.708
R squared	0.8789
F test to compare variances	
F,DFn, Dfd	2.064, 75, 79
P value	0.0017
P value summary	**
Significantly different? (P < 0.05)	Yes

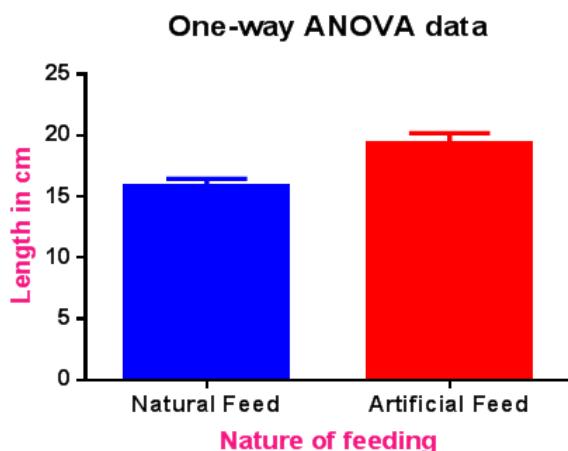


Figure 1 t test with Welch's correction for Length of *Oreochromis Mossambicus* (Cage culture).

The t test Welch's correction for weight for *Oreochromis mossambicus* was described in Figure 2. $t=55.93$ and $df=144.2$ obtained hence according to t test Welch's correction this result is significantly different i.e. $P<0.05$. But these results are not significantly different for F test. When it is compared with variances, the p value is 0.0616.

Table Analyzed	One-way ANOVA data
Column B	Artificial Feed
vs.	vs.
Column A	Natural Feed
Unpaired t test with Welch's correction	
P value	< 0.0001
P value summary	****
Significantly different? (P < 0.05)	Yes
One- or two-tailed P value?	Two-tailed
Welch-corrected t, df	t=55.93 df=144.2
How big is the difference?	
Mean ± SEM of column A	64.66 ± 0.9308, n=80
Mean ± SEM of column B	148.8 ± 1.183, n=76
Difference between means	84.19 ± 1.505
95% confidence interval	81.21 to 87.16
R squared	0.9560
F test to compare variances	
F,DFn, Dfd	1.534, 75, 79
P value	0.0616
P value summary	ns
Significantly different? (P < 0.05)	No

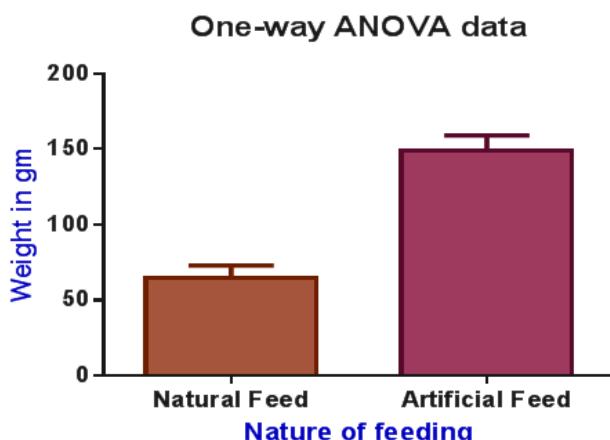


Figure 2 t test with Welch's correction for Weight of *Oreochromis Mossambicus* (Cage culture).

The one day workshop was organized to introduce the idea of fish culture in cages among the fish farmers, businessman, teacher's researchers and students so that activity of fish culture will increase. That would also contribute to countering of the ongoing declining trend in capture fisheries. This will help for addition of another chapter "BLUE" revolution in Marathwada. This workshop was organized on 06/09/2013 with collaboration with College of Fishery Science, Tq. Udgir Dist. Latur. (MAFSU, Nagpur) (Table 3).

Table 3 Physico chemical parameters of river Godavari at Dhangar Takli from July 2012- April 2013.

Months	pH	Temperature (°C)		Transparency (cm)	DO mg/L	CO ₂ mg/L	Chloride mg/L	Alkalinity mg/L	Hardness mg/L	Calcium mg/L	Magnesium mg/L
		Air	Water								
July	7.4	30	28	5.5	8.5	3	52.54	480	190	31.26	13.15
August	7.7	29	28	5	8.16	3.6	34.08	410	164	31.26	12.18
September	8	28	27	19.5	7.7	4.4	39.76	440	172	35.27	14.13
October	7.8	26	25	35.5	6.7	0.4	35.5	240	136	36.87	16.08
November	7.4	29	28	39.5	5.71	0.8	39.76	250	132	17.63	14.61
December	7.6	20	19	41.5	5.1	0.4	28.4	270	142	20.04	16.08
January	7.4	19	18	39.5	7.5	Nil	38.34	320	116	24.84	16.56
February	7.2	17	18	34.5	5.3	Nil	35.5	250	124	23.24	20.95
March	7.8	32	31	46.5	7.7	0.6	46.86	230	110	25.65	33.66
April	7.3	34	32	41.5	5.51	Nil	51.12	270	94	30.46	39.27
SD	±0.25	±5.79	±5.25	±15.26	±1.28	±1.67	±7.75	±92.64	±29.79	±6.38	±9.28

Discussion

⁶conducted study on The Potential of Phytoplankton-based culture of Tilapia (*Oreochromis niloticus*) in floating cages in Seyhan Dam Lake. Their study showed that the growth performance of Tilapia reared in extensive condition is lower than that of intensive and semi-intensive culture conditions. However, when cost of production is considered, extensive cage culture of Tilapia could be an alternative among the other culture models.

Our result showed that the growth of supplementary feed supplied to *Oreochromis mossambicus* was more than the natural feed fish cage. Similar type of work was done by⁷ they found that growth of *Clarias batrachus* (Linnaeus) was more with selected non-conventional diets in a floodplain wetland of Assam in Cage culture.

⁸studied the effects of stocking density (50, 100, 150 and 200fish/m³ cages) for the Nile tilapia [*Oreochromis niloticus* (L.1758)] and found that the fish size and production were significantly affected by stocking density. They had done their experiments on stocking densities and feed quantity of different lakes and reservoir. They had also mentioned that supplementary feed increases the growth performance of *O. niloticus* without harming the water quality.

³Explained the different Traditional and Non-Traditional Methods for Culture of Monosex Nile Tilapia in India.⁹ had done research on Determination of Ideal Stocking Density for Cage Culture of Monosex Nile Tilapia (*Oreochromis Niloticus*) in India and found that the highest growth was observed for the 50fish/m³ groups for both the control and hormone treated categories.¹⁰ Reported that the quantity of the feed given to the stock depends on the utilization and it works to 3 to 5% body weight of the cage reared air breathing fishes; in our study we also provide the artificial feed to the caged fish as per 5% of their body weight.

Some researchers were work on Cage culture by using different species of fishes such as¹¹ fed the *Epinephelus malabaricus* (Bloch and Scheneider, 1801) in Mandapam Coastal waters (Southeast Coast of India) in cage culture with different diets all at a rate of 250 to

350g fish receive 5% body weight daily, 350 to 500g receive 3% body weight daily 500 to 600g. In the present study the fishes fed with artificial pelleted feed with 5% body weight daily.¹² showed the effect of stocking density on yield, growth, and survival of Asian river catfish (*Pangasius bocourti* Sauvage, 1880) cultured in cages. The Asian river catfish, *Pangasius bocourti* cultured in small cages placed in a pond reached the desirable market size (200g) within a 90-day grow-out period. These studies were similar with our findings. Experiment on *Catla catla*, *Labeo rohita*, *Cyprinus carpio*, *Tor pititora* and *Tor Khudree* was carried out by,¹³ they suggested cage culture is feasible for raising fingerlings. They observed that cage culture technique for rearing of seed should be taken up as a fish enhancement programme in which true economic gains will be reflected only when the production of the reservoir is increased.¹⁴ Another work was carried out in Madhya Pradesh on cage culture, the survival % of *Catla catla* was 58.9% and 78.7% whereas it was 63.3%, 57.3% and 74.2% in cages culture. Similar findings were observed in our study. An interesting study was carried out by¹⁵ on Cage Culturing the Endangered Bonytail, in Arizona, U. S. A. The Bonytail *Gila elegans* was the most endangered of endemic Colorado River fishes primarily because of habitat loss and predation by introduced fishes. Results of this study suggested that stocking juvenile bonytails in cages at approximately 18–22fish/m³ and using individuals representing a wide range of body sizes would maximize growth and survivorship. Hence we can use this technique for the culture of endangered fishes also. Similar type of study had been carried out by¹⁶ at same place for *Catla catla* fish; it was observed that *Catla catla* fish also suitable for cage culture in back water of river Godavari. Author was worked on *Catla catla*, important Indian major carp, they showed that this species was also cultivable fish in back water.

Conclusion

The study was concluded that *Oreochromis mossambicus* fish was suitable for cage culture practice in Marathwada region. Artificial feeding is needed to improvement in the total production.

It was found that, all the physico- chemical parameters were

admissible limit for cage culture of *Oreochromis mossambicus*. Although this fish was prolific breeder, it was recommended that instead of culturing both sexes in a cage, the Monosex culture was more suitable for the growth of the fish.

Rearing of this *Oreochromis mossambicus* through cage culture may be useful method to increase the fish production. India stands second position in population hence for fulfill the demand of people cage culture is most needed intensively in order to meet the future food demands and also to improve the aquaculture business in Marathwada region. More experiments should be arranged on cage culture by taking another important fishes for the culture in cages.

Demand of cheapest protein in the form of fish is increases day by day and we are still depending on capture fisheries. The stock is not sufficient to this enormous population hence by accepting the culture technique such as cage culture is considered as the important and need of the day to increase the fish production. The Cage culture technique is not spread yet in this area; hence more workshops should be arranged for the popularization of the cage culture. Successful cage culture practice is helpful to the fish farmers, fishermen and other entrepreneur who are direct related to the fish business. This technique is also helpful for the development of rural communities, if proper support in the form of training was provided to them. It helps them to generate employment opportunity and improvement of livelihood. The role of women in Cage culture is very important as they can play a crucial role in both in both culturing and selling of fresh fishes or manufacturing of various value added products of fishes Nowadays in Marathwada “Mahila Bachat Gat” actively work on various issues for improvement of their socio- economic status.

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Conflicts of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

1. Bulcock P, Ken McAndrew. Planning and extension guidelines for small-scale cage aquaculture in Asia. *Aquaculture News*. 2001;1-3.
2. Fishing Chimes. On promotion of Cage Aqua farming in India. *Connect Journals*. 2008;28(9):7-8.
3. Chakraborty SB, Samir B. Culture of Monosex Nile Tilapia under Different Traditional and Non-Traditional Methods in India. *World Journal of Fish and Marine Sciences*. 2009;1(3):212-217.
4. Trivedy RK, Goel PK. *Chemical and Biological methods for Water Pollution studies*. Karad: Environmental Publication; 1986. 250 p.
5. APHA (American Public Health Association manual). Standard methods for examination of water and waste management. 15th edn. Washington 2000 DC, USA: AWWA-APCF; 2005.
6. Dikel Suat, Gula Kiris, Vedat Alev M. The potential of phytoplankton-based culture of tilapia (*Oreochromis Niloticus*) in floating cages in Seyhan Dam Lake. The 7th Balkan Conference on Operational Research BACOR 05, Romania: Constanta; 2005:1-7.
7. Borthakur Sushanta, Umesh C Goswami. Cage culture of magur *Clarias batrachus* (Linnaeus) with selected non-conventional diets in a floodplain wetland of Assam. *Indian J Fish*. 2007;54(4):357-363.
8. Gibtan Ashagrie, Abebe Getahun, Seyoum Mengistou. The effect of stocking density and supplementary feeding on growth performance and yield of Nile tilapia [*Oreochromis niloticus* (L.1758)] in cage culture in Lake Kuriftu, Ethiopia. *Aquaculture Research*. 2008;39(13):1450-1460.
9. Chakraborty SB, Debasis Mazumdar, Samir Banerjee. Determination of Ideal Stocking Density for Cage Culture of Monosex Nile Tilapia (*Oreochromis niloticus*) in India. *Proc zool Soc*. 2010;63(1):53-59.
10. Murugesan VK, Parameswaran S. Culture of air breathing fishes in cages and Pens. *Proceedings of the National Seminar on cage and pen culture*. Tuticorin: Fisheries College, Tamil Nadu Agricultural University; 1983:59-62.
11. Badhul Haq MA, Srinivasan M, Vignesh R, et al. Cage culture of *Epinephelus malabaricus* (Bloch and Scheneider, 1801) in Mandapam Coastal waters (Southeast Coast of India). *International Journal of Environmental Sciences*. 2011;2(2):491-501.
12. Jiwyan Wirat. The effect of stocking density on yield, growth, and survival of Asian river catfish (*Pangasius bocourtii* Sauvage, 1880) cultured in cages. *Aquaculture Int*. 2011;19(5):987-997.
13. Kohli MP, Ayyapan S, Langer S, et al. Cage culture of carps, *Labeo rohita* and *Cyprinus carpio* at Powai lake, Mumbai, Maharashtra. *Applied Fisheries and Aquaculture*. 2002;11(2):1-4.
14. Tamot Praveen, Rajeev Mishra, Somdutt. Water quality monitoring of Halali reservoir with reference to Cage aquaculture as a modern tool for obtaining enhanced fish production. *Proceedings of Taal2007: The 12th World Lake Conference*; 2008:318-324.
15. Sowka Patricia A, Paul E Brunkow. Cage culturing the endangered bonytail. *North American Journal of Aquaculture*. 1999;61(4):326-330.
16. Jayvardhan V Balkhande, Arvind Kulkarni. A first experiment on cage culture of *Catla catla* in back water of Shankar Sagar reservoir, Vishnupuri Project Dist. Nanded, Marathwada (Maharashtra). *Journal of Innovations in Pharmaceutical and Biological Sciences*. 2017;4(4):78-86.