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Evaluation of water quality parameters in grow out phase of brackish water fish *Chanos chanos* (Milk fish) in floating net cages

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Abstract
Brackish water fish farming, principally of Barramundi or Asian seabass (*Lates calcarifer)* and milk fish (*Chanos chanos*), is more established, being based on hatchery – produced fry and fingerlings. The intensive culture of fish in cages, such as floating net cages is widespread around the world, and is indicated as one of the major methods for intense fish production in the tropics. The Optimum fish production is totally dependent on the physical, chemical and biological qualities of water to most of the extent. Hence, successful cage culture management requires an understanding of water quality. The present study was conducted in the closed bay near Suryalanka, Baptla and Guntur district. By using standard methods (APHA), water quality parameters were measured at 8.00 hrs. on 15days interval for a total period of 90 days. Prior to start of the experiment, the transported fish were acclimated with the sea environment by rearing them in hapa net for one week. The floating net cages used for experiments were of (Hapas of 1m ×1m×2m sizes, fine-meshed polyethylene (PE) net cages (1.25mm) were fixed in the cages. In the present study, different physico-chemical parameters of water were analysed and all the parameters in the floating net cages were within the suitable and safe range for milkfish culture. This paper gives detailed information on water quality parameters such as water temperature, pH, dissolved oxygen, total alkalinity, nitrite, nitrate, ammonia in brackish water fish culture in floating net cages.

Keywords: Brackish water, cage culture, milk fish, stocking density, water quality

Introduction
Brackish water cage culture involves growing fishes in the sea while being enclosed in a net cage which allows free flow of water. It is a production system comprising of a floating frame of varying dimensions and shape, net materials and mooring system, to hold and culture a large number of fishes. The mesh also allows the water to pass freely between the fish and surrounding water resource, thus maintaining good water quality and removing wastes [18]. Cage aquaculture has grown very rapidly during the past 20 years and is presently undergoing rapid changes in response to pressure from globalization and global demand for aquatic products. Brackish water and marine cage farming is relatively new in Asia, having first been developed in japan for marine cage culture for species such as the Japanese amberjack or yellowtail (*Seriola quinqueradiata*) and red seabream (*Pagrus major*) [30]. Brackish water fish farming, principally of Barramundi or Asian seabass (*Lates calcarifer)* and milk fish (*Chanos chanos*), is more established, being based on hatchery –produced fry and fingerlings. The intensive culture of fish in cages, such as floating net cages is widespread around the world, and is indicated as one of the major methods for intense fish production in the tropics [17].
Chanos chanos is the sole species in the family Chanidae in the Order Gonorynchiformes. Milk fish feed on a variety of foods depending in the type of environment. As larvae they feed on zooplankton. As they develop in to juveniles they start to feed on benthic items. The most common food items for juveniles are cyanobacteria, diatoms, detritus, green algae and invertebrates such as small crustaceans and worms. It is euryhaline and can thrive in waters of 0 to 150 ppt salinity [9]. It is cultured commercially in waters of widely ranging salinity, i.e., fresh water lakes, brackish water to hypersaline ponds, warm waters above 20 °C and marine cages. Milk fish breed near shore and shallow waters over sand or coral reefs. Its breeding season is longer near equator. Milk fish may spawn more than once a year and spawning usually takes places during the night. Spawning is highly seasonal and may be influenced by the lunar cycle [4].

The length of the spawning season may be influenced by surface water temperature in certain areas [4, 12]. The main objective of the present study is to analyse crucial water quality parameters in milk fish floating net cage culture.

Materials and Methods

The present study was conducted in the closed bay near Suryalanka, Baptla, Guntur district, Andhra Pradesh for a period of 90 days with 15 days interval. It lies between latitude -15°51' 04.54" N and longitude 80°31'58.87" E. The experimental site is shown in Fig.1 and the experimental setup is shown in Fig. 2.

Fig 1: The experimental site

Fig 2: The experimental setup

Seed collection and acclimatization

Milk fish, Chanos *chanos* seed were collected from wild source in Moolapeta village, U. Kothapeta mandal, East Godavari district. Fish seed were brought in aerated, closed bags and released in to hapas (2m×2m×1.5m) in brackish water fish pond at FRS (Fisheries Research Station), Kakinada and reared for a period of one week. During this period the seed were fed with rice bran. Fish seed were packed in double plastic bags filled with oxygen and 30 ppt water in the ratio 3:1 in each bag and the density of fresh was100/bag. Seed was transported in to hapas within the cage in the experimental site. Before transfer into hapas the seed was slowly acclimatization to water of experimental site for one hour.

The floating net cages used for experiments were of (Hapas of 1m ×1m×2m) sizes, fine-meshed polyethylene (PE) net cages (1.25mm) were fixed in the cages. Outer cage made up of high density polyethylene (HDPE) was used as protection from predators (Predatory net). The net cages were fixed to a bamboo raft. The bamboo raft was used for easy movement, feeding and sampling of the experimental fishes on the cage structure [20].

Assessment of water quality parameters

Water quality parameter like temperature, salinity, dissolved oxygen and pH were measured at 8.00 hrs. on 15days interval. Water samples were transported to the FRS laboratory after collection and analysed.

Table 1: Standard methods used for analysis of Physico-Chemical parameters of water

S. No.	Parameter	Method
1	pH	Digital pH meter (model-HI98107 pH ep® HANNA Instruments, Carrollton, TX, USA).
2	Temperature	Celsius glass thermometer.
3	Salinity	Hand held Refractometer (Erma, Tokyo).
4	Dissolved Oxygen	Titrimetric Winkler's method (APHA, 1995).
5	Total Alkalinity	Titrimetric method (APHA, 1995).
6	Ammonia	(APHA, 1995)
7	Nitrite (NO2)	(APHA, 1995)
8	Nitrate (NO3)	(APHA, 1995)

Results and Discussion

Temperature (°C): The temperature at initial day was recorded as 29.0 °C. The highest and lowest values of temperature recorded were 30.6 °C (on 15th day) and 29 °C (on 1st day and 60th day) respectively. On the 45th day and 90th day sampling the temperature recorded was as same 30.0 °C. which was the highest one. At the end of the experiment the temperature recorded was 30.0 °C. The values recorded during the experimental period slightly fluctuated with a difference of 1.5 °C. The optimum temperature for milkfish culture is 20-43 ºC [29] and the present study readings were within this range 27.6 ^{0}C to 31.1 ^{0}C. According to [22] temperature fluctuations can be a significant factor in the growth of milkfish in nursery and culture ponds that are small or shallow. During the present study temperature is slightly fluctuated and no adverse effect on growth and survival. [23] suggested that the heat death. temperature to be 39 °C for milkfish fingerlings. In the present study recorded temperature (31.1 ^{0}C) is not beyond the above value. According to [21] lethal temperatures for juvenile milkfish are >42.7 °C and <8.5 °C. In the present study recorded temperature values (29 ºC to 30.6 ºC) are at acceptable level. Low temperatures (<23 °C) decrease activity, responsiveness, food intake, growth, and development of milkfish fry and juveniles; high temperatures have the opposite effect [29]. In the present study temperature is recorded more than the above value (>27.6 °C).

Salinity: The initial day salinity was recorded as 28.9 ppt and the highest and lowest values of salinity recorded were 31.1 ppt (on 45th day) and 27.6 ppt (on 60th day). At the end of the experiment the salinity was recorded as 30.2 ppt. Milkfish are able to tolerate hypersaline conditions. Their tolerance limits are at salinities ranging from 0 to 158 ppt [9]. The salinity readings in the present recorded in the net cages were within the tolerance limits of the fish. Growth and FCR of milkfish fry was significantly affected by salinity. According to [1] highest growth was observed in milkfish reared in freshwater and as salinity was increased, growth decreased. Results of present study is in agreement with [13]. He reported that survival and growth of larvae could be improved by rearing at lowered salinities because low levels were iso-osmotic with body fluids, reducing the energy costs of osmoregulation. [6] Gave different ideal levels of salinity as 10- 20 ppt for *P. monodon;* 10-25 ppt for euryhaline species and 25-28 ppt for *P. indicus.* [6] gave a level of 10 ppt suitable for *Mugil cephalus* and [12] suggested 25 ppt for *Chanos chanos* (Forsskal).

Hydrogen ion index (pH): Initially the pH value was recorded as 7.9. The highest and lowest values of pH, recorded during the entire period of experiment were 8.3 (on 60th day) and 7.8 (on 90th day). At the end of the experiment the pH was recorded as 7.8. On the 1st day sampling the pH recorded was 7.9 which was same as on 45th day sampling. Present values was correlated within the range of results recorded by [15, 16, 17, 33] found pH range from7.3-8.0 at milkfish (*Chanos chanos*) production in brackish water ponds in Philippines. According to [25] the suitable pH range for fish culture is between 6.7 and 9.5 and ldeal pH level is between 7.5 and 8.5 and above and below this is stressful to the fishes. Ideally, an aquaculture pond should have a pH between 6.5 and 9 [5, 31].

Dissolved Oxygen (mg/l): The dissolved oxygen was calculated initially after introducing the fishes and the value was recorded as 6.4 mg/l. The highest and lowest values of dissolved oxygen, recorded during the entire period of experiment were 6.4 mg/l (on 1st day) and 4.9. mg/l (on 60th day). At the end of the experiment the dissolved oxygen value recorded was 5.4 mg/l. According to [22] for juvenile milkfish, the lethal minimum level is 0.1-0.3 mg/l oxygen. In the present study dissolved oxygen values are recorded between 4.9 mg/l to 6.4 mg/l. The present studies were conducted in closed bay with moderate water flow (0.05 m. second^{-1}). This may be the reason for better survival of milkfish in present studies. The present values are correlates with results recorded by [5, 6]. DO level >5ppm is essential to support good fish production [2, 4, 5].

Total Alkalinity (mg/l): Initially the alkalinity value recorded was 136 mg/l. The highest and lowest values of total alkalinity, recorded during the entire period of experiment were 164 mg/l (on 60th day) and 136 mg/l (on1st day). At the end of the experiment total alkalinity value recorded as 143 mg/l. The present values are similar and within the limits of results found by [16, 8] suggested that water with total alkalinities of 20 to 150 mg L^{-1} contain suitable quantities of carbon dioxide to permit plankton production for fish culture. According to [31] alkalinity between 75 to 200 mg L^{-1}, but not less than 20 mg L^{-1} is ideal in an aquaculture pond. According to [27] the ideal value for fish culture is 50-300 mg L^{-1}.

Ammonia (mg/l): The ammonia value initially recorded as 0.01 mg/l. The highest and lowest values of ammonia, recorded during the entire period of experiment were 0.35 mg/l (on 45th day) and 0.01 mg/l (on 1st, 75th day). At the end of the experimental ammonia value recorded was 0.02 mg/l. Ammonia toxicity increases with the increase in pH and temperature. In the present study on 45th day ammonia is recorded as 0.03 mg/l. Ammonia toxicity increases with the increase in pH and temperature. In the present study on 45day ammonia is recorded as 0.03 mg/l. The toxic levels for un-ionized ammonia for short-term exposure usually lie between 0.6 and 2.0 mg L^{-1} for pond fish, and sub lethal effects may occur at 0.1 to 0.3 mg L^{-1} [10, 24]. Present recorded values are coincided and similar with results obtained by [10, 24].

Nitrite (mg/l): During the study, nitrite value was recorded as 0.03mg/l and the highest and lowest values of nitrite, recorded during the entire period of experiment were 0.03 mg/l (on 1st day and 90th day day) and 0.01 mg/l (on 30th day and 75th day). Lawson, 1995 [33] recorded nitrite values between 0.01-0.07 mg/l in brackish water fish ponds in Philippines. The ideal and normal measurement of nitrite is zero in any aquatic system [26] suggested that the desirable range 0-1 mg L^{-1} NO_2 and acceptable range less than 4 mg L^{-1} NO_2. According to [4] 0.02-1.0 ppm is lethal to many fish species, >1.0 ppm is lethal for many warm water fishes and <0.02 ppm is acceptable. So as per the above citations, present results are within the tolerable limits for the culture of milk fish.

Nitrate (mg/l): Initially the nitrate value was recorded as 2.15 mg/l. The highest and lowest values of nitrate, recorded during the entire period of experiment were 3.85 mg/l (on 30th day) and 1.95 (on 45th day and 90t day). On the 15th day and 60th day nitrate value recorded was same as 2.25 mg/l. At the end of the experiment the nitrate value was recorded as

1.95 mg/l. Furnas, 1992. [19] recommended that its concentrations from 0 to 200 ppm are acceptable in a fish pond and is generally low toxic for some species whereas especially the marine species are sensitive to its presence. According to [26] nitrate is relatively nontoxic to fish and not cause any health hazard except at exceedingly high levels (above 90 mg L^{-1}) [25] described the favourable range of 0.1 mg L^{-1} to 4.0 mg L^{-1} in fish culture water. However [22], recommends that nitrate levels in marine systems never exceed 100 mg L^{-1}. Present results correlates with results recorded by [25].

Fig 3: Harvested Milk fish (*Chanos chanos*)

Table 2: Water quality parameters recorded during the study period in floating net cages of milk fish (*Chanos chanos*)

Parameter Period (Days)	Temp. (°C)	Salinity	pH	D. O	Total Alkalinity (mg/l)	Ammonia (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)
Initial	28.0	31	8.2	6.4	139	0.01	0.01	1.56
15	28	31	8.0	5.5	147	0.02	0.02	1.25
30	27	32	8.1	6.1	150	0.03	0.01	1.20
45	28	28	8.0	5.8	149	0.02	0.02	1.45
60	29	26	7.9	4.8	158	0.01	0.02	1.28
75	28	26	8.0	4.9	162	0.01	0.01	1.10
90	29	27	7.8	5.6	145	0.02	0.02	1.30

Conclusion

Brackish water aquaculture represents an important activity for economic development and social cohesion in coastal India. It provides valuable export earnings, family wage jobs and food and social security if it developed responsibly. The modern aquaculture like cage culture should adopt an environmental approach integrating aquaculture, environment and society. Of the many factors that affect the production and productivity of aquaculture, soil and water quality play a pivotal role. Deterioration of pond environment leads to stress to animals and increases susceptibility to diseases. Key to successful aquaculture is intervention at the right time through appropriate management practices. Hence, it is imperative to constantly monitor and maintain soil and water quality parameters within the optimum range. In the present study all important water quality parameters recorded were within the suitable and safe range for milkfish culture in cages.

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