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An Assessment of Seasonal Variations in the Water Quality of the Polyculture Ponds

V. Lakshmi Devi.Kantheti[2], A.V.V.S. Swamy[*1], V. Subhashini[2] and S. Srinivasa Raju[3]

[1]*Professor in Environmental Sciences, Acharya Nagarjuna Unitversity, Guntur – Pin: 522510.
[2]Research Scholar, Department of Environmental Sciences, Acharya Nagarjuna University, Guntur – Pin: 522510
[2]Faculty, Department of Environmental Sciences, Acharya Nagarjuna University, Guntur – Pin: 522510
[3]Department of Civil Engineering, Bonam Venkata Chalamayya Engineering College, Odalarevu – Pin: 533210
*Corresponding Author: A.V.V.S. Swamy
Professor in Environmental Sciences, Acharya Nagarjuna University, Guntur.

ABSTRACT: *The present study was carried out to analyse the seasonal variations in polyculture ponds in Tadinada, Kalidindi Mandal, Eluru District and Aripirala, Nandivada Mandal, Krishna District, Andhra Pradesh, for two years. In Tadinada pond, Catla, Rohu and Roopchand are grown. In AripiralaCatla, Rohu and Mrigal are cultured. Catla feeds on the surface. Rohu and Roopchand are mid-column feeders. Mrigal is a bottom feeder. The results obtained from the study were compared with the standard prescribed limits of [5]. The Physico-chemical parameters such as pH, Salinity, Carbonates, Bicarbonate, Total Alkalinity, Total Hardness, Calcium, Magnesium, Nitrates, Nitrites, Ammonia, Total Dissolved Solids, COD, and BOD were estimated using American Public Health Association – [1]. In pre-monsoon season, Salinity, Total Hardness and Magnesium were noticed to be above the standard limits specified by [5]. Total Dissolved solids observed in Tadinada pond during both seasons exceeded the permissible limits. Calcium concentration in pre-monsoon and Total Hardness in post-monsoon at Tadinada pond waters were found to be within the limit specified as acceptable in the absence of an alternate source by [5]. In Aripirala pond, during both seasons, the recorded values of Calcium, Total Dissolved Solids and Magnesium in post-monsoon were conformed with exceptional values prescribed [5].*

KEY WORDS:*American Public Health Association, Nandivada, Aripirala, Catla, Roopchand*

I. INTRODUCTION

Water is an essential requirement for the existence of life. Water controls many aspects of life like economic growth, environmental stability, food security, biodiversity conservation and health care.

[22]have conducted a on the Physicochemical characteristics of River Bhavani waters by taking monthly samples from Pillur dam. They reported higher temperature, turbidity, pH, electrical conductivity, total solids, suspended solids, dissolved solids, and BOD. They have witnessed a clear impact of urbanization, and the waters of the Bhavani River were contaminated heavily by the sewage and industrial wastes.

The quality of Perur lake waters was studied by [14] by collecting monthly samples during the monsoon season and reported a higher level of all parameters. Water quality degradation was attributed to industrial effluents like dyeing, jewellery making, foundries, urban sewage and municipal solid waste dumping. It was concluded that lake waters at Coimbatore District are not suitable for drinking water [25].

II. METHODOLOGY

The present study has been carried out from December'2019 to November'2021 for two years at poly culture fishery ponds of Tadinada - 16.539224^0N and 81.319212^0E (Kalidindi Mandal in Eluru District) and Aripirala - 16.5605197^0N and 80.977997^0E (Nandivada Mandal, Krishna District) Andhra Pradesh. The water

quality of the two polyculture ponds was evaluated in different seasons, i.e., Pre-Monsoon and Post-Monsoon seasons.

Aripirala is an agricultural village widely practicing aquaculture, embracing an area of 752 hectares. Catla, Rohu and Mrigal are reared in the ponds. Some people undertake backyard poultry farming, cattle farming and fodder growing.

Tadinada village is in Kalidindi mandal. The total area of this village is 1444 hectares. Fishes like Catla, Rohu and Roopchand are grown. The major occupation of the people in Tadinada is aquaculture. Few people depend on backyard poultry farming, cattle, sheep and goat rearing for their livelihood.

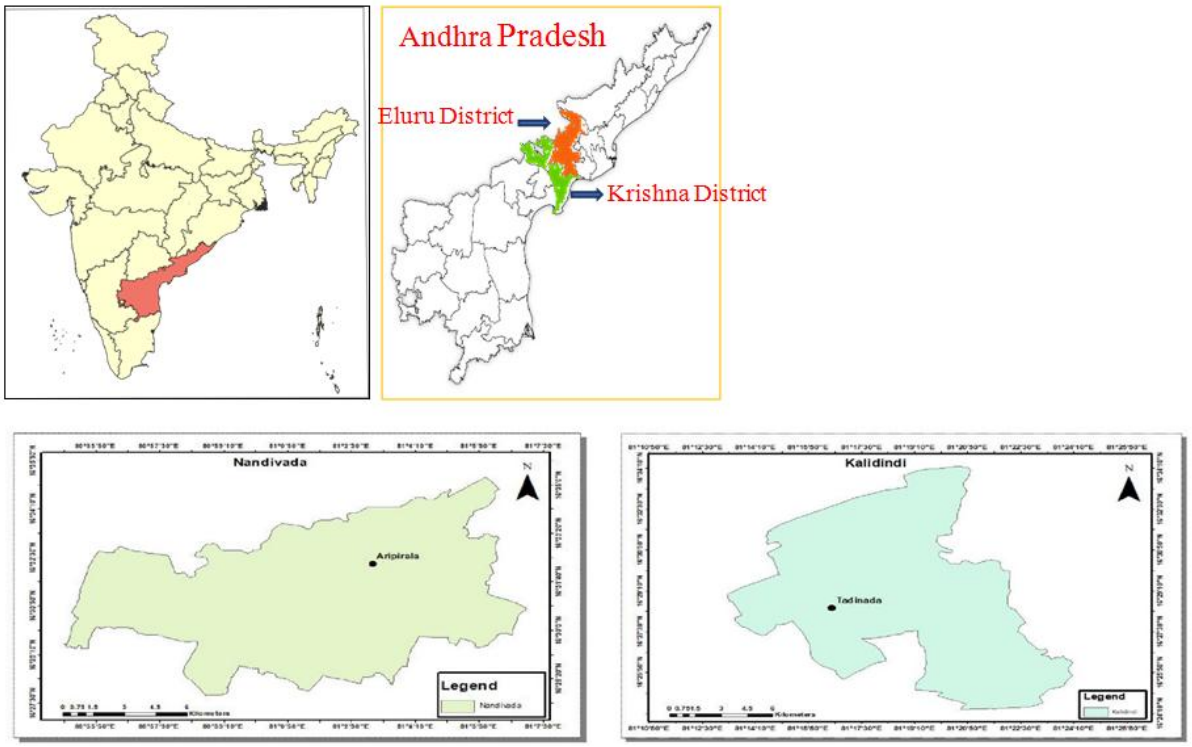

Figure 1: Study Areas: Aripirala and Tadinada Location Maps

The culture carried out by rearing more than one species in a pond is called polyculture, where the species effectively share the space and food resources. The construction of a pond is a significant aspect of polyculture. The depth of the polyculture pond is generally six to eight feet. The management process includes pre-stocking, stocking and post-stocking stages.

In pre-stocking stage firstly aquatic weeds, predators and non-target fishes are removed. Ploughing the bottom of the pond was done after drying the bed till the soil started cracking to destroy the unwanted organisms and the release of intolerable gases from the bed. Application of lime to the pond is essential to regulate the pH of water and soil, disinfection and mineralization of the organic matter. Proportionate numbers of surface, mid-column and bottom feeders are stocked in the pond. Fertilization, feed schedules, water quality monitoring and fish health, are the various processes involved in the post-stocking.

The scientific name of Catla is *Catlacatla*, the leading Indian major carp. Catla feeds on the surface of the pond. Adults depend on zooplankton for their feeding. At the same time, off-springs depend on zooplankton and phytoplankton. Generally, *Labeorohita* and *Cirrhinusmrigala* are grown along with Catla in the polyculture ponds. It is a fast-growing species compared to Rohu and Mrigal.

Labeorohita is a mid-column feeder. It mainly depends on plant and putrescent matter for their feeding. It grows faster compared to Mrigal.

Cirrhinusmrigala feeds at the bottom of the pond. Adult fish feed on Diatoms, green algae, fragments of higher plants, vegetable decays, mud and debris for their food.

Piaractusbrachpomus is the scientific name of Roopchand. It is the mid-column feeder. Fast-growing species and superior quality. It has omnivorous food habit and it also feed on low-cost varieties.

Samples were drawn between 6.00 and 8.00am in a pre-sterilized plastic jar of five litres and drawn at a depth of 10 to 15cm from the water's surface. Different water quality parameters such as pH, Salinity, Dissolved Oxygen, Total Hardness, Calcium, Magnesium, Total Alkalinity, Carbonates, Bicarbonates, Hydrogen Sulphide, Ammonia, Nitrites, Nitrates, Total Dissolved Solids, COD and BOD were estimated in the laboratory using

standard methods of [1]. For the estimation of DO, water samples were drawn into 300ml BOD bottles. MnSO4 and the alkali iodide azide were added to the samples instantaneously at the sampling spot to avoid the degradation of oxygen. Results were expressed in mg/L except for salinity which was denoted as ppt.

III. RESULTS AND DISCUSSIONS

RESULTS

The present investigation was conducted for two yearsatTadinada village, Kalidindi Mandal, Eluru District and at Aripirala village, Nandivada Mandal, Krishna District of Andhra Pradesh. During pre-monsoon and post-monsoon, samples were collected from polyculture ponds. The main aim of the study was to monitor the quality and also to analyse the variations in selected polyculture ponds of Aripirala and Tadinada.

Aripirala polyculture pond during the pre-monsoon exhibited a pH of 8.2, which is slightly alkaline and a salinity of 3ppt. Carbonates were recorded as 5mg/l, and bicarbonates of 420mg/l were noted in the pond water. In the present study area, the total alkalinity of 425mg/l was measured. The pond water represented the total hardness as 1000mg/l. During the study, Calcium and Magnesium levels were found as 100mg/l and 210mg/l, respectively. The present study area has shown nitrates as 23.24mg/l and nitrites as nil. The current water sample has ammonia of 0.1mg/l. During pre-monsoon, Aripirala pond exhibited the Hydrogen Sulphide of 0.18mg/l. 1390mg/l of Total Dissolved Solids were noticed in the collected water sample. The pond water had shown DO of 7.2mg/l and BOD of 2.25mg/l. The water sample used for the study has COD of 560mg/l.

During post-monsoon in the Aripirala polyculture pond, the average pH was 7.9, and 0.9ppt of Salinity was noticed. Carbonates of 2mg/l were noted in a collected water sample. The present pond exhibited bicarbonates of 385mg/l. The total alkalinity of 387mg/l appeared in the water sample. The average total hardness of 400mg/l was recorded in the present study area post-monsoon. Calcium of 80mg/l and Magnesium of 89mg/l were noticed in Aripirala pond. In the current water, sample nitrates were noted as 5.23mg/l, and no nitrites were recorded. The pond water showed ammonia of 0.11mg/l, and Hydrogen Sulphide of 0.25mg/l was detected in the present investigation. The collected sample has the Total Dissolved Solids of 1130mg/l. The water sample collected for analysis has a DO of 2.3mg/l and a BOD level of 10.23mg/l. During post-monsoon in the present study pond, 128mg/l of COD was measured.

During pre-monsoon, in the present investigation at Aripirala pH of the water sample ranged from 7.9 to 8.2, suitable for fish culture. Pre-monsoon has showed higher pH of 8.2 compared to post-monsoon. The pH results in both seasons were within the acceptable limit of 6.5 to 8.5 specified by [5] and [21] for commercial fishing. In the present investigation, Salinity varied from 0.9 to 3ppt during pre-monsoon and post-monsoon. Salinity obtained in pre-monsoon (3ppt) was above the recommended level of 2ppt by [10].

In the present study, the range of carbonates appeared from 2 to 5mg/l. Higher carbonates were found in pre-monsoon (5mg/l) compared to post-monsoon. Throughout the study period, bicarbonates were noted between 385 to 420mg/l. Higher levels of bicarbonates (420mg/l) were noticed pre-monsoon than post-monsoon. Total Alkalinity of 387 to 425mg/l was detected during pre-monsoon and post-monsoon and was found to be above the permissible limit of 200mg/l but below the specified limit of 600mg/l acceptable in the absence of alternated source by [5]. Total Alkalinity of 425mg/l was noticed in pre-monsoon, and 387mg/l was recorded post-monsoon.

Total Hardness was obtained between 400 and 1000mg/l in pre-monsoon and post-monsoon seasons. The Total Hardness recorded in both seasons was above the acceptable limit of 200mg/l. Still, the total Hardness that appeared in post-monsoon was below the limit of 600mg/l that can be used in the absence of an alternate source prescribed by [5]. The calcium obtained during the study ranged from 80 to 100mg/l was above the specified limit of 75mg/l by [5]. The calcium concentrations measured in both seasons were found to be below the limit of 200mg/l permissible in the absence of an alternate source prescribed by [5]. Magnesium ranging from 89 to 210mg/l was detected during pre-monsoon and post-monsoon in the present study area. Magnesium found in pre-monsoon and post-monsoon seasons were noticed above the acceptable limit of 30mg/l, but magnesium recorded in the post-monsoon (89 mg/l) was within the allowable limit of 100mg/l permissible in the absence of alternate source prescribed by [5].

In the present study, Nitrate levels varied from 5.23 to 23.24mg/l were within the acceptable limit of 45mg/l prescribed by [5]. Higher nitrates were noted in pre-monsoon at 23.24mg/l compared to post-monsoon. Nitrates recorded in Aripirala pond are acceptable for fish farming. Nitrite was recorded as nil during both pre-monsoon and post-monsoon seasons in the collected water sample. During the study period, the pond water showed ammonia levels ranging from 0.1 to 0.11mg/l were within the prescribed limit of 0.5mg/l by [5]. Minute variations were noticed in ammonia levels that appeared during pre-monsoon and post-monsoon.

In Aripirala pond water, Hydrogen Sulphide concentration varied from 0.18 to 0.25mg/l in pre-monsoon and post-monsoon seasons. The results obtained for Hydrogen Sulphide in both seasons were above the acceptable limit of 0.05mg/l specified by [5]. Hydrogen Sulphide was noted in post-monsoon as 0.25mg/l and 0.18mg/l in pre-monsoon. The range of Total Dissolved Solids recorded in the present study area is 1130 to 1390mg/l during

pre-monsoon and post-monsoon seasons. In both seasons, the obtained Total Dissolved Solids were found to be above the specified limit of 500mg/l but below the acceptable limit of 2000mg/l permissible in the absence of an alternate source given by [5].

During the study in the Aripirala polyculture pond, the collected sample showed Dissolved Oxygen varying from 2.3 to 7.2mg/l. Dissolved Oxygen appeared as 2.3mg/l in the post-monsoon season, was below the acceptable limit of 3.5mg/l for commercial fishing specified by [21] and is not suitable for the aqua farm. The collected sample exhibited an average BOD from 2.25 to 10.23mg/l during pre-monsoon and post-monsoon. The BOD observed in Pre-monsoon as 2.25mg/l was within the acceptable limit of 3mg/l prescribed by [21]for commercial fishing. The current study area COD content ranged from 128 to 560mg/l in pre- and post-monsoon seasons and was found to be above the recommended limit of 50mg/l mentioned by [18]. Presently, no specific limit is mentioned for COD by [5] and [21]for commercial fishing.

Table I: Comparison of mean values of water quality parameters in Aripirala Polyculture Fishery Pond

S.NO	PARAMETERS	ARIPIRALA	
		PRE-MONSOON	POST-MONSOON
1	pH	8.2	7.9
2	Salinity ppt	3	0.9
3	CO_3 mg/l	5	2
4	HCO_3 mg/l	420	385
5	Total alkalinity mg/l	425	387
6	Total Hardness mg/l	1000	400
7	Ca^{2+} mg/l	100	80
8	Mg^{2+} mg/l	210	89
9	NO_3 mg/l	23.24	5.23
10	NO_2 mg/l	0	0
11	Ammonia mg/l	0.1	0.11
12	H_2S mg/l	0.18	0.25
13	TDS mg/l	1390	1130
14	DO mg/l	7.2	2.3
15	BOD - 5-day mg/l	2.25	10.23
16	COD mg/l	560	128

During the pre-monsoon season in Tadinada village, the polyculture pond showed a pH of 8.3 and a Salinity of 4ppt. Carbonates were 20mg/l, whereas bicarbonates were 540mg/l. A total alkalinity of 560mg/l was recorded. The pond water showed a total hardness of 1000mg/l. Calcium and magnesium were noticed as 80mg/l and 211mg/l. In the present study, nitrates were 27.36mg/l and nitrites were nil. Ammonia was recorded in the pond water as 0.2mg/l. The concentration of Hydrogen Sulphide was 0.28mg/l. In the present study, Total Dissolved Solids were 3100mg/l. The DO was 6.2mg/l. The sampleshave showed BOD content of 8.25mg/l and 560mg/l of COD in the pre-monsoon season.

The post-monsoon samples have exhibited a pH of 8.05. Salinity in the pond water was recorded as 2ppt. 16mg/l of Carbonates and Bicarbonates of 400mg/l were noted in the water sample. Total alkalinity of 416mg/l was recorded in the sample. The pond water has shown a Total Hardness of 550mg/l. Calcium concentration of 70mg/l was noted. Magnesium was recorded as 100mg/l. The nitrates were 6.81mg/l in the pond, and while the nitrites were nil. Ammonia was found to be 0.2mg/l during the post-monsoon season. Hydrogen Sulphide was recorded as 0.3mg/l. The pond water possessed 2500mg/l of Total Dissolved Solids. 5.5mg/l of DO was found in the water sample. The concentration of BOD was recorded as 4.95mg/l, and COD was noted as 128mg/l during the post-monsoon season.

In the present study, at Tadinada, the average pH of the samples ranged from 8.05 to 8.3, which was moderately alkaline. Higher pH of 8.3 was noted in the pre-monsoon season compared to post-monsoon (8.05). In both the seasons the pH was ideal for fish growth. Salinity in the pond water during pre-monsoon and post-monsoon were varied from 2 to 4ppt. In pre-monsoon season, the salinity of 4ppt was noted higher than in post-monsoon. The salinity recorded in the pre-monsoon season (4ppt) was above the recommended of 2ppt by [10].

During the study period of two years, Carbonates in the Tadinada polyculture pond were recorded between 16 and 20mg/l. Higher levels of carbonates (20mg/l) were found in the pre-monsoon, and lower classes were noticed in the post-monsoon season. Bicarbonates recorded in the pond water ranged from 400 to 540mg/l. Pre-monsoon has shown concentrations of bicarbonates as 540mg/l compared to post-monsoon season. The collected water sample showed total alkalinity concentrations ranging from 416 to 560mg/l. The total alkalinity was higher in the pre-monsoon than in the post-monsoon season (416mg/l). However, the concentration of bicarbonates and total alkalinity were much higher than the prescribed limit of 200 mg/l but were below the concentration permitted under no alternative source, i.e., 600mg/l by [5].

In the present study, total hardness in the Tadinada pond ranged from 550 to 1000mg/l during pre-monsoon and post-monsoon seasons. A higher concentration of total hardness was noted in pre-monsoon as 1000mg/l exceeded both the 200mg/l actual acceptable limit and 600mg/l permissible in the absence of an alternate source specified by [5]. The calcium in the pond varied from 70 to 80mg/l in pre-monsoon and post-monsoon seasons and was found to be favourable for fish culture. In pre-monsoon little high level of calcium was noted at 80mg/l than in post-monsoon. The magnesium concentration in the present study ranged from 100 to 211mg/l. Magnesium concentrations were higher in pre-monsoon compared to post-monsoon (100mg/l). The magnesium recorded during pre-monsoon (211mg/l) was also found to be above the acceptable limit of 100mg/l in the absence alternate source specified by [5].

The pond water showed nitrates ranging from 6.81 to 27.36mg/l, within the acceptable limit of 45mg/l [5], suitable for fish culture. In the pre-monsoon season (27.36mg/l), higher nitrates were noticed compared to post-monsoon. In the Tadinada polyculture pond, nitrites were nil during both seasons. In the present investigation, the collected water sample showed a similar concentration of ammonia in both seasons at 0.2mg/l and was within the acceptable limit of 0.5mg/l [5].

The Hydrogen sulphide was 0.28 to 0.3mg/l. Little variations were found in the concentration of Hydrogen Sulphide in both seasons. The result obtained for Hydrogen sulphide during both seasons was above the permissible limit of 0.05mg/l specified by [5]. The pond water exhibited the total dissolved solids varying from 2500 to 3100mg/l. Total dissolved solids were found in pre-monsoon was 3100mg/l and in the post-monsoon season was 2500mg/l. Total dissolved solids recorded in both seasons have exceeded both the acceptable limits of 500mg/l and 2000mg/l permissible in the absence of an alternate source specified by [5].

Dissolved oxygen was recorded from 5.5 to 6.2mg/l during both seasons at the Tadinada polyculture pond and fulfilled the concentration of 4mg/l prescribed for commercial fishing by [21]. Safe margins of Dissolved oxygen was noted as 6.2mg/l in pre-monsoon compared to post-monsoon. The pond water exhibited a BOD concentration ranging from 4.95 to 8.25mg/l, above the permissible limit of 3mg/l for commercial fishing prescribed by [21]. A higher level of BOD was noted in pre-monsoon (8.25mg/l) than in post-monsoon season. The collected water sample noticed COD varying from 128 to 560mg/l during pre-monsoon and post-monsoon seasons. Both seasons' COD recorded exceeded the recommended 50mg/l by [18]. In both [5] and [21]for commercial fishing, there is no specific limit for COD.

TableII: Comparison of mean values of water quality parameters in TadinadaPolyculture fishery pond

S.NO	PARAMETERS	TADINADA	
		PRE-MONSOON	POST-MONSOON
1	pH	8.3	8.05
2	Salinity ppt	4	2
3	CO_3 mg/l	20	16
4	HCO_3 mg/l	540	400
5	Total alkalinity mg/l	560	416
6	Total Hardness mg/l	1000	550
7	Ca^{2+} mg/l	80	70
8	Mg^{2+} mg/l	211	100
9	NO_3 mg/l	27.36	6.81
10	NO_2 mg/l	0	0
11	Ammonia mg/l	0.2	0.2
12	H_2S mg/l	0.28	0.3
13	TDS mg/l	3100	2500
14	DO mg/l	6.2	5.5
15	BOD - 5 day mg/l	8.25	4.95
16	COD mg/l	560	128

IV. DISCUSSION

The rearing of more than one fish species with varied habitats and food habits in a single pond is known as polyculture. Farmers stock the pond by considering that there should be no competition among fish for food or space. Catla, Rohu, Mrigal, Roopchand etc., are commonly grown in Indian polyculture ponds.

Physico-chemical characteristics of water are crucial to attaining a healthy yield. Regular water quality monitoring is essential for its sustainable farming. Various physicochemical parameters such as pH, Salinity, Carbonates, Bicarbonates, Total Alkalinity, Total Hardness, Calcium, Magnesium, Nitrates, Nitrites, Ammonia, Total Dissolved Solids, Dissolved Oxygen, Biochemical Oxygen Demand and Chemical Oxygen Demand etc., are essential for maintaining a healthy aquatic environment required for growth of fish in the pond [2].

pH is a measure of whether water is acidic or basic. [18] reported that 6.7 to 9.5 pH is the suitable range for a culture of fish, and a pH level from 7.5 to 8.5 is perfect but below and above 7.5 to 8.5 is difficult for

fish to sustain. In the present study, pH ranged from 7.9 to 8.3, denoting a moderately alkaline ideal for fish growth. pH in both the ponds during pre-monsoon and post-monsoon were within the acceptable limit of 6.5 to 8.5 prescribed by [5] and [21] for commercial fishing. A higher pH value of 8.3 was noticed in the Tadinada pond during pre-monsoon, and lower pH of 7.9 was seen in the post-monsoon season at the Aripirala polyculture pond. Both ponds recorded high pH values in Pre-monsoon compared to post-monsoon. [11] registered average pH ranged from 7.22 to 7.32 in three urban ponds with different management practices at Kolkata of West Bengal, India, and observed results were suitable for the culture of fisheries. [13] carried out a study on extensive, semi-intensive and intensive culture systems in fish ponds surrounding Manila Bay, Philippines reported average pH ranging from 7.89 to 8.10 during flooding and during draining from 8.08 to 8.31 were within the appropriate range for fish growth.

Salinity denotes the total concentration of electrically charged ions such as calcium, magnesium, carbonates, bicarbonates etc., present in water [8] and [3]. Usually, freshwater fish species exhibit low tolerance to more changes in water salinity [16]. A salinity of 2ppt is the desirable limit for common carp recommended by [10]. In the present investigation, salinity was noticed from 0.9 to 4ppt. The high salinity of 4ppt appeared during pre-monsoon at Tadinada pond, and a lower concentration of salinity was recorded post-monsoon at Aripirala polyculture pond as 0.9ppt. In both ponds, higher salinities were noticed in the pre-monsoon season than in the post-monsoon. Salinity found in post-monsoon season at Aripirala and Tadinada ponds were tolerable limits for fish culture. Kanjia lake [12] noticed salinity from 0.23 to 0.27ppt was within the recommended level of 2ppt mentioned by [10].

The slight variations observed in the carbonate levels in the present study areas are not noticeable. In the current study, bicarbonates obtained ranged from 385 to 540 mg/l. Higher levels of bicarbonates were recorded in the pre-monsoon season at Tadinada pond at 540mg/l, and lower classes were noticed in the post-monsoon at Aripirala culture pond at 385mg/l. Alkalinity is the capability of water to withstand changes in pH. It is a portion of the total amount of bases such as carbonates, bicarbonates, hydroxides, dissolved calcium, magnesium and other substances in the water. [19] have mentioned total alkalinity of 50 to 150mg/l (CaCO3) as a desirable range. Above 20mg/l and less than 400 mg/l are acceptable limits for fish ponds. During the study period in the selected culture ponds, total alkalinity varied from 387 to 560mg/l. The study findings showed that both bicarbonates and total alkalinity were found to be above the permissible limit of 200mg/l. But below the exceptional limit of 600mg/l specified by [5] in the absence of an alternate source. [9] in Hau River at AnGiang and Can Tho Provinces, Vietnam recorded total alkalinity ranging from 60.7 to 67.5mg/l was found to be suitable for fish culture. [17] noticed total alkalinity in Nizerneshwar and Nimon ponds ranging from 140 to 223mg/l and 160 to 33mg/l located at Sangmner Taluk of Ahmednagar, Maharashtra, India, was appropriate for culture ponds.

Total hardness measures the amount of calcium and Magnesium in the pond water. Calcium and Magnesium play a significant role in metabolic activities such as bone and scale formation required for fish culture. In the present study areas, the results obtained for total hardness were between 400 and 1000mg/l. In both, the study area's total hardness noted exceeded the desirable limit of 200mg/l specified by [5]. But the total hardness recorded during the post-monsoon season in both the stations as 550mg/l in Tadinada and 400mg/l in Aripirala ponds were below the limit of 600mg/l which can be used only in the absence of an alternate source [5]. [24] recorded the total hardness in the ponds around Gurgaon Canal Nuh Palwal were ranged from 410 to 460mg/l and was found to be below the exceptional limit of 600mg/l specified by [5]. [12] reported total hardness in Kanjia Lake, Bhubaneswar ranging from 17.94 to 19.23mg/l, found to be suitable for aquaculture.

Calcium is usually available in the soil as carbonate, and significant environmental divalent salt is present in aquatic ponds. Fish get calcium from the water or food. In the current investigation, both ponds exhibited average calcium from 70 to 100mg/l during pre-monsoon and post-monsoon seasons. The study noted that only in Tadinada pond during post-monsoon (70mg/l) calcium was within the desirable limit of 75mg/l prescribed by [5]. In the remaining areas, during pre-monsoon at Tadinada pond and in Aripirala during both seasons, the calcium was noticed above the desirable limit of 75mg/l. Still, it was well below the exceptional limit of 200mg/l specified by [5]. [6] measured the calcium ranging from 78 to 108 mg/l in the Himalayan Pond of Thittai village, Thanjavur district was found to have higher than the permissible limit of 75mg/l. But as per the acceptable limit of 200mg/l admissible in the absence of an alternate source specified by [5] present water of Himalayan Pond is suitable for fish culture.

The study areas of Tadinada pond waters and Aripirala polyculture ponds in pre-monsoon and post-monsoon magnesium was noticed from 89 to 211mg/l were found to be above the desirable limit of 30mg/l prescribed by [5]. Magnesium observed during post-monsoon in both the study ponds conforms to the exceptional limit of 100mg/l specified by [5] in the absence of an alternate source. [20], during their study in water quality assessment of Lahru pond, Himachal Pradesh, noted magnesium varied from 28 to 36mg/l within the allowable range for culture ponds. [23] detected the magnesium of 230mg/l in the pond water situated near Nandani mines in Durg District, Chhattisgarh, India is not favourable for fish culture.

The dissolved form of solids existing in water is termed total dissolved solids. Different types of minerals, such as carbonates, bicarbonates of calcium, magnesium, sodium, iron etc., in the water represent total dissolved solids. During the study in selected polyculture ponds at Tadinada and Aripirala villages, total dissolved solids were found from 1130 to 3100mg/l during the pre-monsoon and post-monsoon seasons. Compared to the Tadinada pond, the result obtained for total dissolved solids in the Aripirala culture pond (1130 to 1390mg/l) were found to be below the limit of 2000mg/l acceptable in the absence of an alternate source specified by [5]. [15] recorded that the total dissolved solids ranging from 440.86 to 453.59mg/l in four selected stations near Tanganyika Lake, Africa were within the desirable limit of 500mg/l prescribed by [5] were suitable for fish culture ponds. [24] noticed total dissolved solids varying from 653 to 726mg/l in the ponds around Gurgaon Canal Nuh Palwal were suitable for fish culture per the exceptional limit of 2000 mg/l acceptable in the absence of an alternate source.

Aquatic organisms' growth, survival, distribution, behaviour and physiology mainly depend on the concentrations of Dissolved Oxygen present in the pond. Reduced Dissolved Oxygen concentration in aqua ponds causes poor fish feeding, starvation, stunted growth and increased fish mortality, either directly or indirectly [4]. Exposure of fish from 1 to 3ppm of DO shows the sublethal impact on growth and feeding capacity. Exposure to the range from 0.3 to 0.8ppm leads to fish mortality, and above 14ppm causes offspring mortality and gas bubble disease for adult fish. The present culture ponds exhibited DO ranging from 2.3 to 7.2mg/l during pre-monsoon and post-monsoon seasons. The results obtained for DO are higher in pre-monsoon than a post-monsoon season in both the stations of Tadinada (6.2mg/l) and Aripirala (7.2mg/l) polyculture ponds. Aripirala pond DO recorded as 2.3mg/l during the post-monsoon season was below the desirable limit of 4mg/l specified by [21] suitable for commercial fishing. In Aripirala, during the post-monsoon season, to avoid the problem due to DO level of 2.3mg/l, Oxygen tablets or powder form of 2kg per acre or Hydrogen peroxide of 1 litre per acre were added. [15]reported Dissolved Oxygen ranged from 7.162 to 7.71mg/l in four selected sampling stations of Lake Tanganyika, Africa was the suitable range for fish culture. [7] detected the DO of 4.72 to 6.13mg/l in the ponds from the twenty-seven selected villages of the Bilaspur district of Chhattishgarh, India, which were in appropriate condition to carry out fish production.

V. CONCLUSION

The present investigation was carried out in polyculture fishery ponds in Tadinada, Kalidindi Mandal of Eluru District, and at Aripirala village, Nandivada Mandal of Krishna District, Andhra Pradesh, for the period of two years from December'2019 to November'2021. The major occupation of people living in Tadinada and Aripirala villages is aquaculture. The marginal farmers adopt backyard poultry, cattle farming, growing fodder, and aquaculture as secondary occupations. The study's main objective is to evaluate seasonal changes in the water quality of two polyculture fishery ponds belonging to two districts. Various parameters, including pH, Salinity, Carbonates, Bicarbonates, Total Alkalinity, Total Hardness, Calcium, Magnesium, Nitrates, Nitrites, Ammonia, Hydrogen Sulphide, Total Dissolved Solids, Dissolved Oxygen, BOD and COD, were analysed using standards methods of [1].

The water quality variations between the polyculture fishery ponds were compared during pre-monsoon and post-monsoon seasons. In the present study at the culture ponds during pre-monsoon and post-monsoon seasons, the physicochemical variables of pH, Carbonates, Nitrates, and Ammonia were found to be within the acceptable limits specified by [5]. In both the stations during both seasons, nitrites were nil. Bicarbonates and Total Alkalinity obtained in both stations in both seasons were within the exceptional limit of 600 mg/l acceptable in the absence of an alternate source prescribed by [5]. In Tadinada and Aripirala polyculture ponds during pre-monsoon Salinity, Total Hardness and Magnesium were noticed to be above the standard limits specified by [5]. Total Dissolved solids observed in Tadinada pond during both seasons exceeded the permissible limits. Calcium concentration in pre-monsoon and Total Hardness in post-monsoon at Tadinada pond waters were found to be within the limit specified as acceptable in the absence of an alternate source by [5]. In Aripirala pond, during both seasons, the recorded values of Calcium, Total Dissolved Solids and Magnesium in post-monsoon were conformed with exceptional values prescribed by [5].

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