A COMPARATIVE ASSESSMENT OF WATER AND SOIL QUALITY IN SELECTED DITCHES OF MAVELIKARA TALUK, ALAPPUZHA DISTRICT, KERALA


Project Submitted to the University of Kerala
in Partial Fulfillment of the Requirements for the
Degree of Bachelor of Science

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CERTIFICATE

This is to certify that this project entitled "A COMPARATIVE ASSESSMENT OF WATER AND SOIL QUALITY IN SELECTED DITCHES OF MAVELIKARA TALUK, ALAPPUZHA DISTRICT, KERALA" is an authentic record of the work carried out by AKSHAY PRASANNAN, NIMISHA MATHEW, ADITHYA S., ANUSREE J., PARVATHY S. NAIR and SUKANYA MOHANAN B.Sc. Zoology (VI semester) student under my supervision and guidance and that no part of this report has been submitted earlier for any other degree or diploma.

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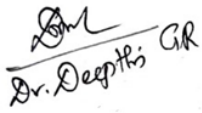

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DECLARATION

I ……. do hereby declare that this project entitled '**A COMPARATIVE ASSESSMENT OF WATER AND SOIL QUALITY IN SELECTED DITCHES OF MAVELIKARA TALUK, ALAPPUZHA DISTRICT, KERALA '** is the bonafide work carried out by me under the supervision and guidance of Dr. Reeja Jose, Assistant Professor, Department of Zoology, Bishop Moore College, Mavelikara for the partial fulfillment of the requirements for the degree of Bachelor of Science and that no part of this project work has been submitted earlier for award by any other degree, diploma or recognition of any university.

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CONTENTS

INTRODUCTION

Water is the second most important need for life to exist after air. As a result, water quality has been described extensively in the scientific literature. The most popular definition of water quality is "it is the physical, chemical, and biological characteristics of water" (Spellman, 2013). Water is one of the most important of all the natural resources known on Earth. It is a vital component for living organism. The chemical integrity involves the regular monitoring of water bodies which determines the biological species composition as well as anthropogenic requirements (Alley, 2007).

Water is the basic and most essential requirement for the life on Earth. Earth surface has limited sources of freshwater and contributes only 2.5% to the total water on the Earth (Hu *et al.,* 2018). From human health to proper functioning of an ecosystem, everything depends upon the water (Costanza *et al*., 2017). Water can be used for recreation, drinking, fisheries, agriculture or industry. Each of these designated uses has different defined chemical, physical and biological standards necessary to fulfil the respective purpose. For example, there are stringent standards for water to be used for drinking or swimming compared to that used in agriculture or industry (Ritabrata, 2019).

Water quality analysis is of extremely necessary in the sectors of Public Health (especially for drinking water) and Industrial use. It is required mainly for monitoring purpose. The water of the ponds, lakes and rivers are polluted mainly due to the discharged waste water from residential area, sewage outlets, solid wastes, detergents, automobile oil wastes and

agricultural pesticides from the farmlands (Bhuiyan, 2007). The large-scale urban growth due to increase in population or migration of people from rural area to urban area has increased domestic effluents while industrial establishments resulting in generation copious volume of industrial effluents (Arvind and Shweta, 2016).

Water quality is determined by various physico-chemical and biological factors, as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals (Dinesh *et al.,* 2017). A sharp drop or increases within these limits have adverse effects on their body functions (Kiran, 2010). So, good water quality is essential for survival and growth of fish. Water quality is not constant; varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, and feeding rate and culture systems. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration (Sikoki and Veen, 2004).

Due to uncontrolled increase in human population and development of township at large, these freshwater bodies are under tremendous pressure owing to their overuse on one hand and enrichment due to nutrients and organic matter on the other, leading to the cultural eutrophication. In most of the countries, fishes are cultivated in ponds (lentic water) but unfortunately such culturists are not so aware of importance of water quality management in fisheries. If they are properly guided and make aware about water quality management practices, they can get maximum fish yield in their ponds to a greater extent through applying low input cost and getting high output of fish yield (Dinesh *et al.,* 2017).

The soil condition is very important to determine the water quality and the survival and growth of fish. The benthic organism helps to lose the soil and make it more susceptible to erosion by water current and also enhance the aeration of upper soil by facilitating the exchange of pore water. When the aquatic organisms died, they contribute organic matter to the soil. Hence the aquatic animals are contributing to the development of soils. Relationship between aquatic soil and aquatic animal production is mostly indirect. Soil affects nutrient concentration in the water, in turn influence plant productivity. In ditches, where aquaculture species depends on natural food for their growth and development, fertility of the soil is the key factor regulating the fish production.

The basic function of aquatic soil is an embankment that impound water and forms barriers to seepage so that the pond will hold the water. The substances that enter the soil may be transformed to other substances by physical, chemical and biological means. As the organic matter deposited on the pond bottom is decomposed to inorganic carbon and released to the water as carbon dioxide. Nitrogen compound may be denitrified by the soil microorganism and lost to the atmosphere as nitrogen gas. Bacteria, fungi, algae, higher aquatic plants, small invertebrates and other organisms together known as benthos live in and on the bottom of the soil. Also, many fishes lay egg in the nest built in the bottom.

It also involved in gas exchange, primary and secondary productivity, decomposition and nutrient cycling. The equilibrium concentration may be too low for optimal phytoplankton growth or the equilibrium concentration of the heavy metal may be too high enough to cause toxicity to aquatic animal. Animal decomposition of microbes is common as the organic matter

is oxidized to carbon dioxide and ammonium and nutrient element is released. And the carbon dioxide and ammonium are highly soluble and quickly enter the water.

Agricultural drainage ditches are essential for the removal of surface and ground water to allow for crop production in poorly drained agricultural landscapes. Ditches also mediate the flow of pollutants from agroecosystems to downstream water bodies. Ditches provide a unique opportunity to address nonpoint source pollution problems from agriculture due to the concentration of the contaminants and the engineered nature of ditch systems. (Needelman *et al.,* 2006).

Ditches are unique ecosystems in that they integrate characteristics of streams and wetlands. Some ditches are straightened streams with stream bottom sediments while others are intermittent wetlands with perennial vegetation throughout the ditch bottom and thick accumulations of soil organic matter. Ditches range in size from small depressed channels designed primarily to carry surface runoff to major channelized streams draining large watersheds and regional groundwater. Because of their engineered nature, ditches do not follow natural fluvial networks, though mechanisms of fluvial geomorphology do function to shape ditches. Ditches serve as primary conduits for drainage and therefore carry pollutants from agroecosystems to downstream water bodies. Ditches also function to control water tables in the landscape, influencing landscape hydrologic, chemical, and biological processes, and serve as active zones of chemical and biological activity to transform, emit, and retain various pollutants (Needelman *et al.,* 2006).

The chemistry of ditch systems is complex with dissolved, colloidal, and particulate materials interacting within soils, sediments, and organisms

through chemical and biogeochemical pathways. Ditches provide aquatic and wetland habitat across landscapes, including many that wouldn't otherwise have these habitats. Ditch vegetation species composition within ditch bottoms and along banks is affected by soil and water table characteristics (Pierce *et al.,* 2007), ditch structure, grazing, nutrient inputs, ditch management and eutrophication status (Bouldin *et al.,* 2004). Macroinvertebrates are diverse and active in many ditch systems and may be useful as indicators of ditch environmental quality (Langheinrich *et al.,* 2004).

In spite of having a central role in the life of all organism, ponds and ditches are continuously being degraded due to anthropogenic activities viz industrialization, urbanization, habitat loss, pollution etc. (Mishra *et al.,* 2014, Chen *et al.,* 2019). Therefore, regular monitoring of physico-chemical and biological parameters would aid in assessing the status of water body and it helps to maintain the primary, secondary, and tertiary production in balance. The present work focusses on the study of physico-chemical characteristics of water and soil sample collected from two ditches (Chaals) of selected villages of Mavelikara Taluk of Alappuzha district in Kerala.

Objectives of the Study

- To identify the major impacts of pollution in the study area
- To make a comparison study between two ditches
- To impart public awareness regarding present pollution status
- To suggest water quality protection programs

MATERIALS AND METHODS

In the present study, the variations in selected physico-chemical factors of water and soil were investigated for a period of three months (February-April, 2022) to determine the water quality of two ditches in Mavelikara Taluk of Alappuzha district in Kerala.

I. STUDY SITES

SITE 1: CHAAL (KLALA00382)

This site is situated in Mannar Panchayat of Mavelikara Taluk at 9.317907^0 N Latitude and 76.502648^0 E Longitude. Present condition of pond is polluted.

SITE 2: KAPPICHAAL (KLALA00129)

This site is situated near Akkanadu Devi Temple in Thazhakara Panchayat of Mavelikara Taluk in Alappuzha district at 9.242898^0 N Latitude and 76.56382^0 E Longitude.

II. SAMPLE COLLECTION AND ANALYSES

In order to assess the water quality of the study areas, water and soil samples were collected during February - April, 2022. Physico chemical parameters like Temperature, pH, Dissolved Oxygen and Carbondioxide were analyzed in chemical laboratory within 6 hours of their collection. Water samples were collected in 500 ml wide mouthed polypropylene bottle for analyzing water quality. Analyses of physical parameters like Temperature and pH were done in the field using thermometer and pH indicator papers. Dissolved Oxygen and Carbondioxide were estimated by following the standard methods of APHA (2005). Soil Analysis was carried out for various parameters such as pH, Organic carbon, phosphorus and

nitrogen using Soil Testing Kit. Then descriptive statistics were conducted using modified SPSS version.

Dissolved oxygen in water

The Winkler Method is used to determine the concentration of dissolved oxygen in water samples. The dissolved oxygen in the sample is then "fixed" by adding a series of reagents (KI and $MnSO_4$) that form an acid compound that is then titrated with a neutralizing compound ($Na_2S_2O_3$) that results in a colour change. The point of colour change is called the "endpoint," which coincides with the dissolved oxygen concentration in the sample.

Carbon dioxide in water

The 40ml sample water is pipetted out in a conical flask. A few drops of phenolphthalein were added to it. Then titrated the sample against .01 N NaOH solution taken in the burette. The end point was marked by the appearance of pink colour.

Organic carbon in soil

A full spoon of soil was taken in a mixing bottle and added 5 ml of organic carbon reagent - 1 and mixed well. 5 ml of organic carbon reagent - 2 was added very slowly and mixed well and allowed to stand for 10 minutes to complete the reaction. Transfer the supernatant liquid into a test tube and compared with the organic carbon colour chart.

pH of soil

Transferred 10 c.c of soil into the soil mixing tube and 25 ml of pH reagent – 1 was added, then shaked well for 5 minutes. A pinch of decolourizer was added into it and shaked well. Filter the soil mixture into the colour developing bottle using funnel and filter paper. To the clear filtrate 4-5 drops

of pH reagent -2 was added. Wait for another 2-3 minutes, then compared the colour developed with the pH colour chart.

Nitrogen in soil

Transferred 5 c.c of the soil in the soil mixing tube and 25 ml of nitrogen reagent -1 was added and shaked well. Add a pinch of decolouriser was added into it and mixed again. Filter the soil mixture into the colour developing bottle using funnel and filter paper. To the clear filtrate, 2 drops of nitrogen reagent -2 was added for developing colour. Then the colour was compared to the nitrogen colour chart.

Phosphorous in soil

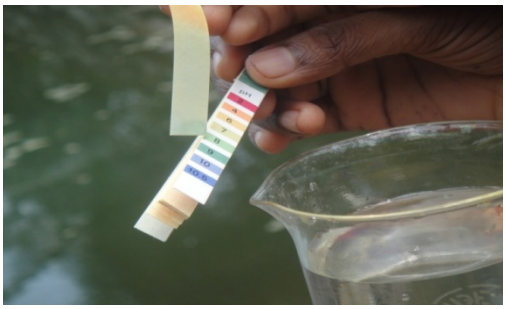
Transferred 5 c.c of the soil into the soil mixing tube and 25 ml of phosphorous reagent-1 was added. Then mixed well and wait for 15 minutes. A pinch of decolouriser was added into it and mixed. Filter the soil mixture into the colour developing bottle using funnel and filter paper. To the filtrate, add 2 ml of phosphorous reagent-2 and mixed well. Wait for 1-2 minutes for colour developing. Then the colour was compared to the phosphorous colour chart.

STUDY SITES

SITE 1: CHAAL

SITE 2: KAPPICHAAL

SAMPLE COLLECTION AND ANALYSES



RESULTS

In the present study, a comparative analysis was carried out on the physico-chemical parameters of water and soil sample collected from two ditches of Mavelikara Taluk, Alappuzha district, Kerala. During the period of study from February to April 2022, the water samples for physico-chemical analysis were collected monthly. Among the water quality parameters, temperature, pH, dissolved oxygen and carbon dioxide were analyzed. The soil quality was assessed by analysing soil pH, organic carbon, nitrogen and phosphorus.

Physico-chemical Analyses

A. Water Quality

1. Temperature

The water temperature of Site 1 – Chaal was recorded as 26^{o}C, while Site 2 - Kappichaal was 25 ^{o}C (Table 1, Fig 1).

2. pH

The pH of water was always near to acidic side at two ditches. (Table 1). The pH of water at Chaal was 5, while that of Kappichaal was 6.5 (Fig 2).

3. Dissolved Oxygen

The DO content of water at Site-1 was 2mg/l (Table 1, Fig 3). The highest value was reported at Chaal compared to Kappichaal (1.6mg/l)

4. Carbon dioxide

The carbon dioxide content of water sample collected from Site-1 was 8.8mg/l (Table 1, Fig 4). It was recorded maximum at Site -1 compared to Site – 2 (6.6mg/l).

B. Soil Quality

1. Soil pH

The pH of soil was always near to acidic range at both ditches. It ranged from 5-6.5 (Table 1). The pH of soil of Site -1 was 5, while that of Site – 2 found to be 6.5 (Fig 2).

2. Organic carbon

The organic carbon content of the soil samples was found to be 0.5- 0.75 % in both sites (Fig). It comes in a medium range.

3. Nitrogen

In the present study, the nitrogen content in soil samples from Site -1 and Site -2 were <50kg/Acrc; indicating that they were comes in L1 level.

4. Phosphorus

The Site- 1, Chaal and Site -2, Kappichaal has >15kg/Acrc [H2 level] of phosphorus. Here, Phosphorus content of soil was found to be high in both Chaals.

Table 1. Physico chemical parameters of water and soil samples collected from two diches

SAMPLE SITES	CHAAL	KAPPICHAAL
WATER QUALITY		
Temperature	26°C	25 °C
pH	5	6.5
DO	2mg/L	1.6mg/L
CO_2	8.8 mg/L	6.6 mg/L
SOIL QUALITY		
pH	5	6.5
ORGANIC CARBON	0.5- 0.75% (Medium amount)	0.5- 0.75% (Medium amount)
NITROGEN	**<**50 kg/Acrc (L_1 level)	**<**50 kg/Acrc (L_1 level)
PHOSPHORUS	**>**15 kg/Acrc (H_2 level)	**>**15 kg/Acrc (H_2 level)

Fig1. Variations in water temperature in selected study sites

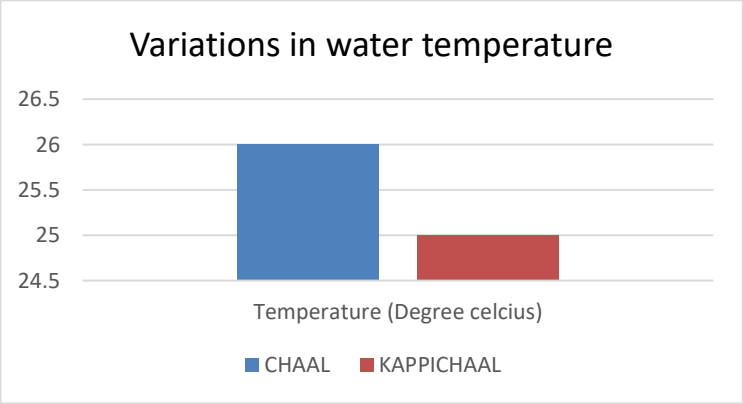


Fig2. Variations in water and soil pH in selected study sites

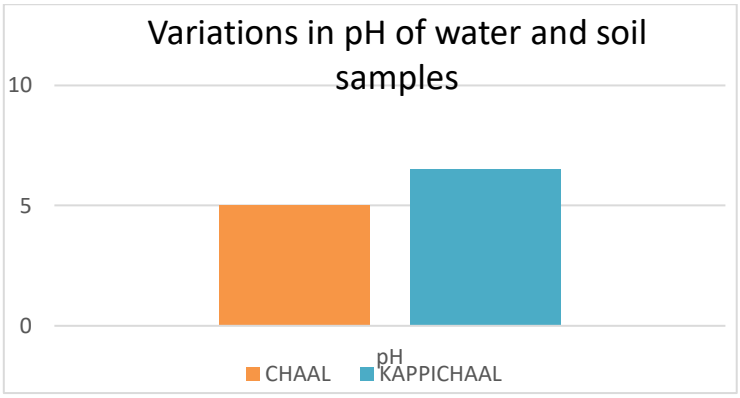


Fig3. Variations in Dissolved Oxygen in selected study sites

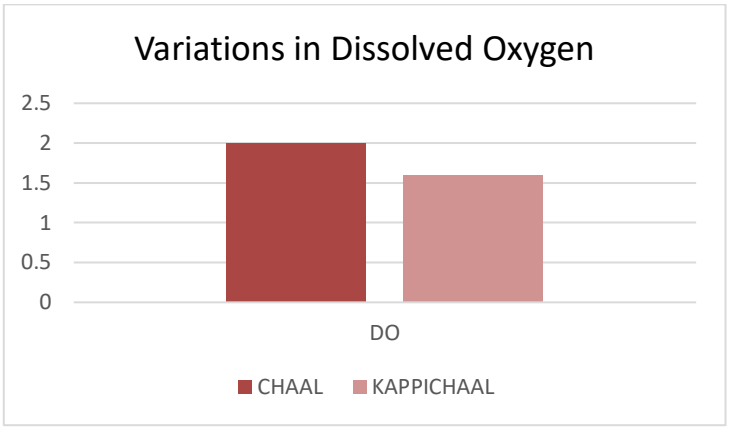
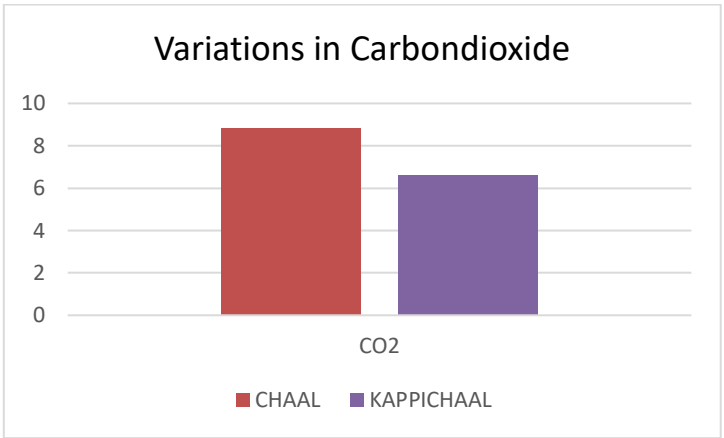
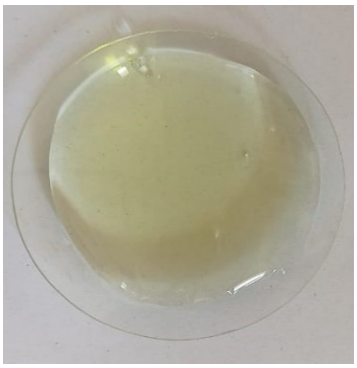


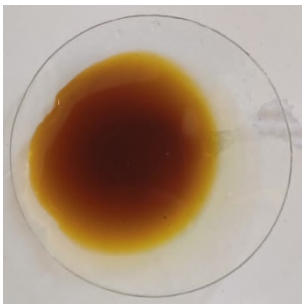
Fig4. Variations in Water Carbondioxide in selected study sites



PHOTOGRAPHS - SOIL ANALYSES

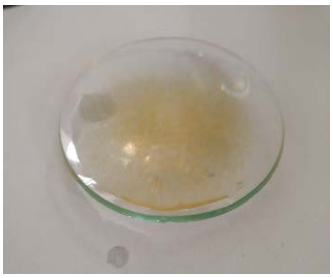


Soil pH -CHAAL

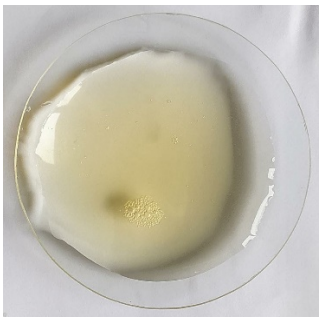


Soil OC- CHAAL

Soil pH -KAPPICHAAL



Soil Nitrogen -CHAAL



Soil Phosphorus- KAPPICHAAL

DISCUSSION

Water quality is a measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose (Shah, 2017). Water quality is often overlooked in management practices and poor water quality can lead to common problems such as excessive algal bloom, overgrowth of plants, noxious smell or dead and dying of fishes (Abhishek *et al.,* 2020). In order to prevent this problem, an understanding of basic water chemistry and other physical parameters is necessary. Determination of physico-chemical characteristics of water is essential for assessing the suitability of water for various purposes like drinking, domestic, industrial, irrigation and pisciculture (Bronmark and Hansson, 2005).

In the present study, the physico-chemical characters of water and soil sample collected from two Ditches (Chaals) of selected panchayath of Mavelikara Taluk of Alappuzha district in Kerala were compared with analyzing standards such as Temperature, pH, Dissolved Oxygen (DO), Carbondioxide (CO_2), Organic Carbon, Nitrogen and Phosphorus.

An ideal pond water should have a temperature between 20°C and 25°C and making sure it should not to exceed 29°C. Water that reaches a temperature above 29°C become hazardous to the fish lives in the pond. In Chaal (Site 1) the water temperature was 26°C, which is not above 29°C. Hence it is be considered as an optimum temperature. Where as in kappichaal (Site 2) it was around 25°C. It was observed that, water at temperatures of 10–15°C is accepted as most palatable (APHA, 2005). Water temperature may also depend on the seasons, geographic location and sampling time (Ntenegwe and Edema, 2008).

pH is one of the most important parameters of water quality and it measures whether the water is acidic or basic. According to WHO (2011), the permissible limit is 6.5 - 8.5 which is considered as safe range for drinking water, domestic use and living organisms need. Fishes have an average blood pH of 7.4. So, pond water with a pH close to this is optimum. Fish can become stressed in water with pH ranging from 4.0 - 6.5 and 9.0 - 11.0. Here in Chaal, pH was found to be 5 and Kappichaal has pH 6.5. These were not considered as an acceptable range of pH. Pure water is neutral, with a pH close to 7.0 at 25°C.

The pH of freshwater ponds can fluctuate considerably both daily and seasonally. These fluctuations are due to photosynthesis and respiration by plants and animals (Dinesh *et al.,* 2017). The slight deviation towards acidity in water samples can be attributed to the anthropogenic activities like improper irrigation process and weathering process in the study area. pH value also depends on the geology of the area.

Dissolved oxygen is the factor that determines whether the biological changes are brought about by aerobic or by anaerobic organisms. In the present study, it was observed that the DO amount is less than the permissible value. The permissible limit is 6mg/l according to WHO, 2009. In Chaal (Site 1) the DO is 2mg/l and in Kappichaal (Site 2) the DO is 1.6mg/l. Hence, it begins to have detrimental effect on pond life. It led to deccaying of vegetation and other organic matters. It will give off a strong odor due to insufficient dissolved oxygen in pond. Here in this study, the excessive algal growth may be the reason for lowering DO and it increases the CO_2 level in water.

Dissolved oxygen is an important parameter in water quality assessment and reflects the physical and biological processes of aquatic life. Oxygen is needed by fish and other aquatic organisms. DO vary daily

and seasonally and depends on the species of phytoplankton present, light penetration, nutrient availability, temperature, salinity, water movement, partial pressure of atmospheric oxygen in contact with the water, thickness of the surface film and the bio-depletion rates (Dhavran and Karu, 2002). Nduka *et al.,* 2008 reported that the optimum dissolved oxygen for fish ponds is >4mg/l. Moreover, DO is known to affect attributes such as growth, survival distribution, behavior and physiology of aquatic organism (Emerson and Abell, 2002). Low oxygen content in water is usually associated with organic pollution.

Carbon dioxide in a water body may be derived from the atmospheric sources, biotic respiration, inflowing ground water which seep into the pond, decomposition of organic matter due to bacteria and may also from within the water body itself in a combination of other substances mainly calcium, magnesium etc. (Dinesh *et al.,* 2017). According to Ekubo and Abowei, 2011 tropical fishes can tolerate CO_2 levels over 100 mg/l but the ideal level of CO_2 in fish ponds is less than 10 mg/l. The free carbon dioxide in water supporting good fish population should be less than 5mg/l (Bhatnagar and Singh,). In the present investigation, Chaal (Site 1) CO_2 was 8.8 mg/l and Kappichaal (Site 2) CO_2 is 6.6 mg/l. These values fall within the optimum range.

The correct balance where the soil pH is to have been between 5.5 – 7.5. In Chaal (Site 1) the soil pH is 5 and Kappichaal (Site 2) is 6.5. Hence, these values were considered as within an optimum range. Organic matter has a high concentration of carbon that average 58%. The concentration of sediment organic carbon usually is below 4% in pond bottom and in new ponds the soil can contain less than 0.25 % organic carbon. The amount of organic carbon in pond bottom can increase as a result of increasing carbon concentration in sediment, increasing depth of sediment or both.

Here the concentration of organic carbon in Chaal (Site 1) and Kappichaal (Site 2) were 0.5 - 0.75%, which means the organic carbon content in both sites are in medium amount.

In soil, the best balance is achieved by moderate soil nitrogen supply (25 – 50 mg – N/kg soil). In contrast, in loam and clay soil high soil nitrogen supply is most suitable (50 – 75 and 75 – 125 mg- N /kg soil. In the present study, Chaal(Site 1) and Kappichaal (Site 2) the values were <50kg/Acrc; indicating that they were comes in L1 level. Healthy level of phosphorus in soil ranges from 25 – 50 ppm. Here Chaal and Kappichaal has >15kg/Acrc [H2 level]. Relationship between aquatic soil and animal production is mostly indirect. Phosphorus content of soil was found to be high in both Chaals. So, it adversely affects the vegetation.

This study provides a better understanding of the nature of this complex ecosystem. The results of physico-chemical parameters clearly shows that the water is not good for human consumption and also struggling for their existence. So, there is an immediate need for restoration, improvement and proper management of these water bodies for the human and environment.

Remedies and Measures

There is a need of awareness among the local people to maintain the ditches at least their optimum quality and purity levels. The onset of monsoon helps in diluting the pollutants but awareness and proper management practices such as planting trees around ditches, regularly recharging during summer period, removal of sediments from the bottom, removal of floating debris from the surface, diversion of sewage discharge to proper disposal site and proper enforcement of law and policy might be very successful.

CONCLUSION

Water is one of the vital components for living organisms. Water quality is an important part of environmental monitoring which is essential part of keeping the planet healthy and sustainable. When water quality is poor, it affects not only aquatic life but the surrounding ecosystem. The present study was carried out to analyse various physiological and chemical characters of water and soil sample collected from two Chaals (ditches) named Chaal (KLALA00382) and Kappichaal (KLALA00129) of selected village (Mannar and Thazhakara) of Mavelikara Taluk of Alappuzha district in Kerala. This study was conducted for a period of three months from February to April 2022. The water quality of both ditches was compared by analysing parameters such as water temperature, pH, dissolved oxygen, dissolved carbon dioxide, soil pH, organic carbon, nitrogen, phosphorus etc.

In this study, the water temperature was observed to be high. The reason for this higher water temperature in both Chaals may be due to the high turbidity during summer season. The pH value of water was found to be above the permissible limit. It may be due to the influence of geology of these areas. Amount of dissolved oxygen was very less than the permissible limit. The permissible limit is 6 mg/L as per standards of WHO. Amount of dissolved carbon dioxide in water was also found to be higher than the permissible limit.

Soil quality was analysed by using soil testing kit. Soil pH in the Chaal (Site 1) and Kappichaal (Site 2) were ideal for aquatic plants. Both the Chaals have medium amount of organic carbon. The phosphorus content

of soil was high in both Chaals. So, it adversely affects aquatic life. Nitrogen content was found to be low in both Chaals.

The present study, indicate the polluted condition of these water bodies. This study helps in water quality monitoring and management. It also enables to improve the quality of water with maintaining better sustainable management. Pollution can be reduced by providing proper sanitation facility and by providing proper methods for dumping of municipal sewage, domestic wastes etc. The water quality can be improved by creating awareness in local public about this degrading status, by making farmers understand about proper use of fertilizers and pesticides in farms.

Moreover, findings from this study revealed that regularly monitoring water parameter such as temperature, pH, DO etc provide insight to the health of the aquatic ecosystems. This work also provides a base line data for the conservation and monitoring of the studied areas.

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