Environmental Science
ISSN: 0974-7451

Environmental Science: An Indian Journal

Research Article | Vol 18 Iss 4

Assessing The Physico-Chemical Parameters of Rain Water Harvested Ponds in Yeswanthapura Village, Mallur, Kolar District, Karnataka, India

Hari Prasad HK[1*], Jayashree DR[2], Lakshmi Kanth RN[2], A Nagarathna[2], Malini MR[3], Debanjana Roy[4], Mahesh M[4]

[1]Department of Environmental Sciences, Bangalore University, Bengaluru, India

[2]Department of Biotechnology, M.S. Ramaiah College of Arts, Science and Commerce, Bengaluru, India

[3]Department of Biochemistry, M.S. Ramaiah College of Arts, Science and Commerce, Bengaluru, India

[4]Department of Genetic, M.S. Ramaiah College of Arts, Science and Commerce, Bengaluru

[*]**Corresponding author:** Hari Prasad HK, Department of Environmental Sciences, Bangalore University, Bengaluru, India, Tel: 8150039335; E-mail: hariprasadlego@gmail.com

Received: June 28, 2022, Manuscript No. tses-22-67980; **Editor assigned:** June 30, 2022, PreQC No. tses-22-67980; **Reviewed:** July 14, 2022, QC No. tses-22-67980; **Revised:** August 29, 2022, Manuscript No. tses-22-67980; **Published:** September 05, 2022, DOI: DOI: 10.37532/0974-7451.2022.18.218

Abstract

A sound planning to ensure the available water quality for the best use in an irrigated agriculture is dependent on adequate water supply of useable nutrients. The objective of the current study delineates for better understanding of the effect of physical, chemical and biological parameter from rain water harvested ponds in Yeswanthapura village, Malur taluk, Kolar district, Karnataka, India. Water samples were collected from 11 different black polyethylene sheet catchment areas. Standard electronic sensors like Hanna pH and TDS meters, Lutron D.O meter and fem water analysis kits were used to analyze the selected physical and chemical parameters of water. The analyzed results were subjected to WHO and BIS standard permissible limits. The water color was clear in S5, S6, S8 and S9, while S4 had slightly fishy odor. The physical parameters like pH ranged from 6.5-9.5, while, turbidity and TDS was 0.46 ± 0.05 (NTU) to 8 ± 0 (NTU) and 28.02 ± 0.072mg/L to 891.32 ± 0.39mg/L respectively. The chemical parameters Calcium, Magnesium, Sodium, Chloride, Potassium, Nitrate and Phosphate were within the maximum desirable limits with few exceptions. DO values were under standard acceptable edge. The status of physical and chemical parameters showed that these water indices were not toxic. The study recommends that screening of rain water harvested ponds helps in conservation and maximum utilization of the ponds for agriculture and horticulture making the groundwater invisible to visible in the farms, increasing the socioeconomic needs with an effective ecosystem especially, in rural dry semiarid areas.

Keywords: ***Rain harvest, Parameters, Conservation, Fem, Ground water***

Introduction

Rain water harvesting could represent a way to tackle increasing aridity and water scarcity, among agriculture [1]. Water consumption has offered many opportunities for agriculture by use of Rain water harvesting [2]. Irrigation in agriculture leads to increased environmental impact, but, harvested rain water can reduce the impacts on human health, environment, storm water runoff, combines sewer overflows and economic viability improving water management in an affordable manner [3-7]. Improvement in water productivity could represent a good option to increase crop yields through rain water harvesting in irrigation of rain fed crops and also, its supplementary irrigation could increase crop yield by more than 30% [8,9].

Citation: Hari Prasad HK, Jayashree DR, Lakshmi Kanth RN, et al. Assessing The Physio-Chemical Parameters Of Rain Water Harvested Ponds in Yeswanthapura Village, Mallur, Kolar District, Karnataka, India. Environ Sci Ind J. 2022;18 (4):218

Water quality is an important issue when considering application of harvested rain water and depends on many factors. The moment it rains from clouds, the uptake of contaminants occurs, either as particulate matter or as solutes [10]. A healthy ecosystem relies on the physico-chemical nutrient parameters [11]. For agricultural and natural system rainwater harvesting ponds and assessment of water quality is necessary for good ecosystem productivity. Thus, sustainable utilization of land and water resources and its conservers of the environment as remained as one of the major policy issues in many developing regions [12]. Different physico-chemical parameters are essential before it is used for agriculture, drinking, domestics or for any industrial purposes. Physical tests like physical appearance, odor, pH, temperature, turbidity, Total Dissolve Solid (TDS). While, chemical tests Calcium, Magnesium, Sodium, Chlorine, Potassium, Nitrate and Phosphate and biological assessment like dissolved oxygen [13].

Most of the studies dealt on fresh water storage system are mainly focused on drinking water, but, less attention has been shown on rain fed agriculture in arid and semi-arid areas, as they represent 90% of total production of cereals of these regions. Hence, increasing productivity of rained areas could lead to an increase in food security, reduction in irrigation frequency and improvement in livelihood and rural conditions. The objective of this study was to investigate physico-chemical and biological nutrient parameters of rainwater harvested ponds, used for agriculture crops. The results will support the promotion of using rainwater harvesting at large scale effectively and sustainably.

Methodology

Water sample collection

A total of 11 samples, were collected randomly, without specific parameters between 7.00 am and 11.00 am from different areas each with a distance of 2 to 5 kilometers of the rain water harvesting ponds on agriculture farm, from Yeswanthpura village, Malur taluk, Kolar district, India. The polyethylene sheet catchments area measuring (l x b x h), minimum of 100 x 100 x 35 feet and maximum of 150 x 150 x 35 feet, collected during the rainy season in the month of July 2021. Sample of 3-5 liters of surface water (0.3 to 0.5 meters) was taken, to avoid surface scums [14,15], into a clean, sterile glass container for the nutrients assessment. The APHA standard methods were followed for collection, preservation and analysis of various parameters [16].

Physico-Chemical analysis

All the 11 samples were labeled after collection. Analysis for color, odor, pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), turbidity (NTU), Nitrate, Phosphate, were taken in the field, at the time of sampling using electronic sensors like potentiometric sensors, voltammetry sensors and Field Effect Transistor (FET) sensors i.e. Hanna pH and TDS meters, Lutron D.O meter and fem water analysis kits. While, for Calcium, Magnesium, Chlorine, Sodium and Potassium analysis, samples were carried to the laboratory in ice tanks and analyzed using standard methods and the results were tabulated prescribed by WHO and BIS standard [17,18].

Statistical analysis

Descriptive statistics were applied to determine the mean values of all physical, chemical and biological parameters evaluated. Standard deviations were computed using Microsoft excel for measuring the variance. A study was considered for different parameters of water, physical parameter like, color, odor and turbidity (NTU). Chemical parameters like, pH, Total Dissolved Solids (TDS), Sodium, Chlorine, Calcium, Magnesium, Potassium, Nitrate and Phosphate. While, for biological parameters only Dissolved Oxygen (DO) was considered.

Results and Discussion

Color

The color of the water varied in each of the ponds. Some of the samples were colorless with hint of green (algal growth). While few others were, clear, cloudy, muddy. The imbalance (high amount) of nitrates and phosphate levels in pond water providing algae with the nutrients to grow but, a negative effect on fishes and other aquatic lives [19].

Odor

Except for S4 sample with fishy smell, remaining samples were odorless, this may be caused by bacteria, which slowly breakdown organic compounds at the bottom of a pond using enzymes or presence of decaying aquatic life. While, the odorless samples were due to the aerobic bacteria, which can effectively breakdown the organic matters in the ponds [20].

Turbidity

During the study period in selected ponds, turbidity was reported within the range from 0.45 ± 0.05 NTU to 8.0 ± 0.02 NTU. The turbidity of S11 was highest and lowest in S6. Silt, clay and other suspended particles contribute to the turbidity values, as it was a monsoon season. Similar report has been reported with high turbidity during rainy season. The seasonal variation for turbidity has been proved, during winter season due to settlement of silt, clay resulting low turbidity has stated by Figure 1.

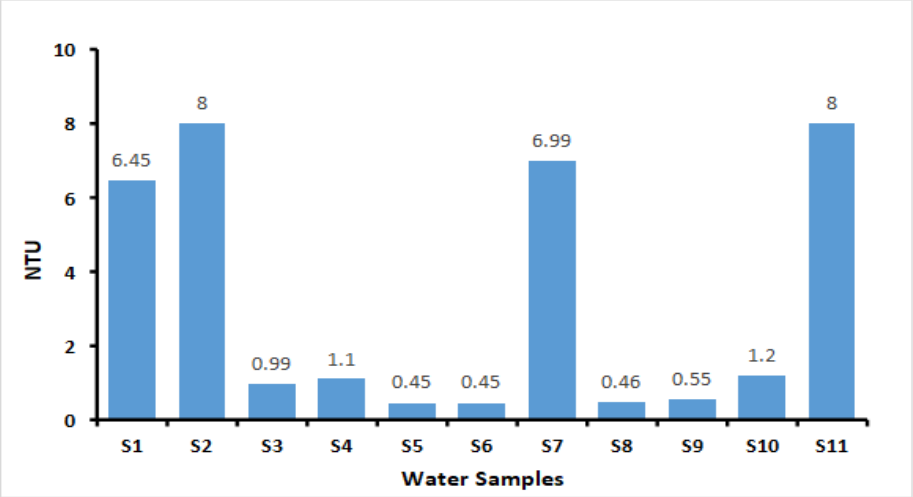

FIG.1. **Turbidity from samples 1-11.**

pH

The highest pH was 9.2 ± 0.1 in S1 and lowest was 7.13 ± 0.15 in S6. pH means H^+ ions are compensated with OH^- ions. pH in alkaline trend during the study period [26]. pH is affected not only by the reaction of carbon dioxide but also by organic and inorganic solutes present in water [27]. Any alteration in water pH is accompanied by the change in other physico-chemical parameters [28]. The pH for natural water is usually between 6.5 and 8.5 although variations are known to occur. At extreme high or lowpH values such as greater than 9.6 or less than 4.5, the water becomes unsuitable for most organisms (Figure 2).

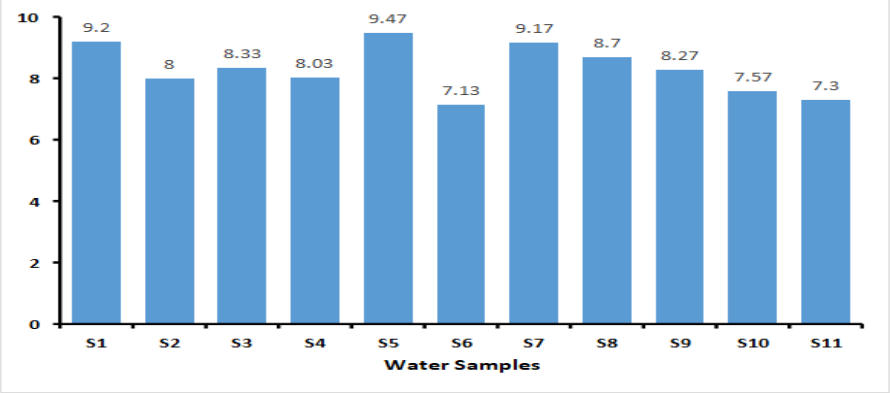

FIG.2. **pH from samples 1-11.**

Total Dissolved Solids (TDS)

The study revealed the highest value of Total Dissolved Solids in S6 890±1.53mg/L and lowest value was 27 ± 2.52 mg/L in S7. The present study TDS values can be related with previous reports with the maximum TDS during pre-monsoon season and lowest during monsoon in Shathamraj and Ibrahimbag reservoirs of Hyderabad. Total dissolved solids reduce the water clarity decreases photosynthesis and increases water temperature. The climatic conditions as well as human interference might have affected the TDS. According to WHO the standard permissible limit for TDS is 500-2000 mg/L. The BIS has set desirable limit of TDS value to be 500 mg/L in potable water. However, the permissible limit is 2000 mg/L in the absence of any alternative source in water.Water at a TDS level of above 500 mg/L is not suitable for flora and tastes unpleasant to drink. TDS enrichesthe nutrients status of water body which leads to eutrophication of the aquatic ecosystem. In water TDS are composed mainly of carbonated, bicarbonates, chlorides, phosphates, and nitrates of calcium, magnesium, sodium, potassium, organic matter salt and other particles. Many studies have been under taken to the assessment of total solids in various pond water samples reported previously (Figure 3).

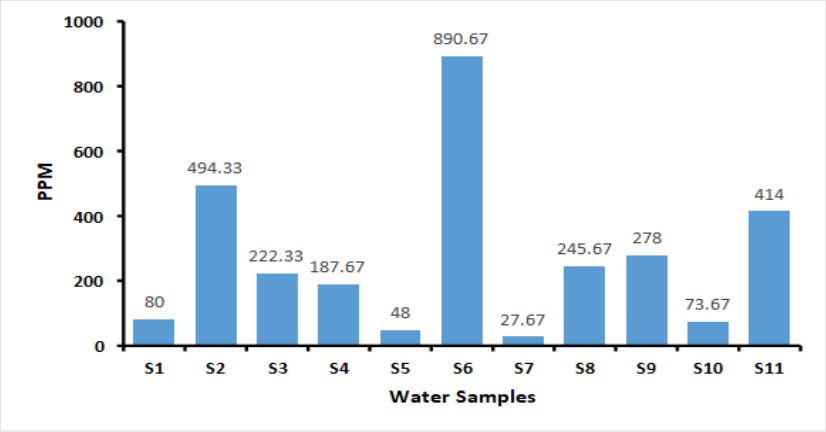

FIG.3. **TDS from samples 1-11.**

Sodium

The major ions sodium was, high with 6.20± 0.04mg/L in S9 while, lowest in S8 of 0.60±0.08 mg/L. The hardness of water is not pollution parameter but indicates water quality mainly in terms of calcium, chlorine and sodium (Figure 4).

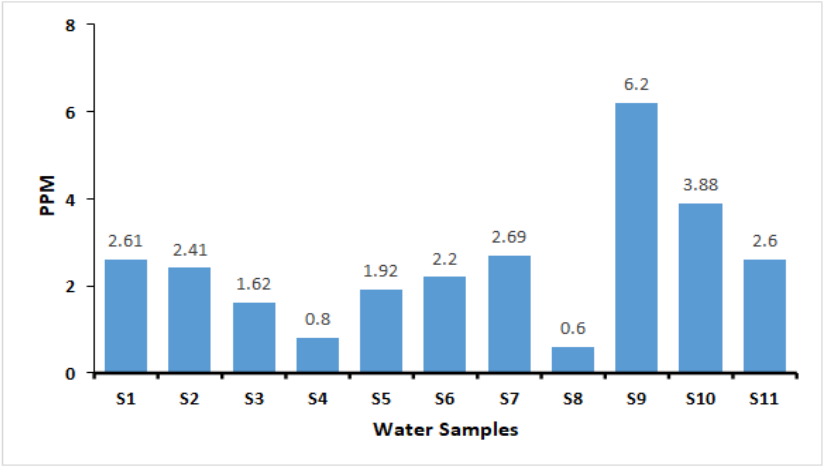

FIG.4. **Sodium from samples 1-11.**

Chlorine

Chlorine is a natural element found in nature, anions found in water are generally combined with calcium, magnesium or sodium. The chlorine value in the water sample ranges between 0.43 ± 0.03 mg/L to 2.56 ± 0.05 from S1-S11. As such in S4 and S8 chlorine was absent. It is necessary to check the effectiveness of chlorination of raw water for public water supply through the estimation of free or residual Cl_2 in water samples. Free available Cl_2 consists of Cl_2, HOCl and $HClO_2$. The higher concentration of Cl_2 in ponds implies that the pond water may be polluted and harmful to aquatic life (Figure 5).

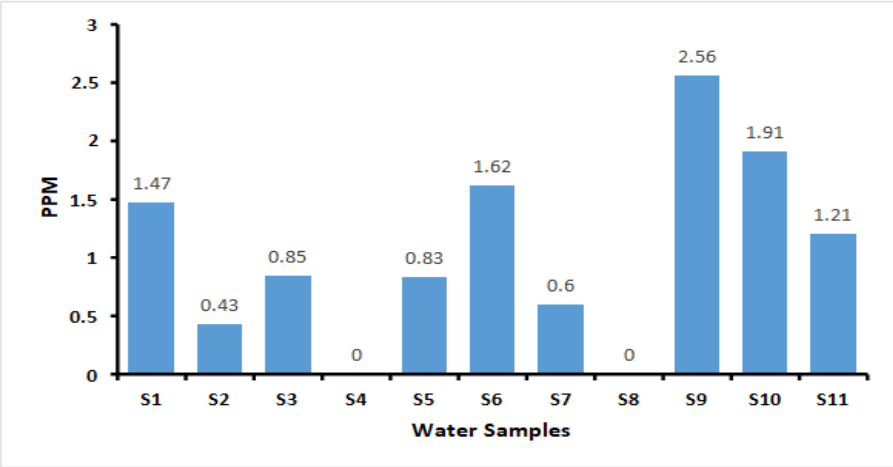

FIG.5. **Chlorine from samples 1-11.**

Calcium

Calcium ions in the water samples of pond revealed lowest in S2 of 0.46 ± 0.09 mg/L and highest in S9 of 1.61 ± 0.03 mg/L. organisms reacts with ion Ca^{2+} in the environment resulting in the subsequent precipitation of minerals. Calcium functions to minimize the rise in pH that can occur when the photosynthesis rates are high. Calcium is generally present in soil as carbonate and most important environment element associated with different cations like carbonates, bicarbonates and fluorides to exert hardness [14]. Calcium in the form of the Ca^{2+} ion is one of the major inorganic cations,or positive ions, in saltwater and freshwater. It can originate from the dissociation of salts, such as calcium chloride or calcium sulphate in water (Figure 6).

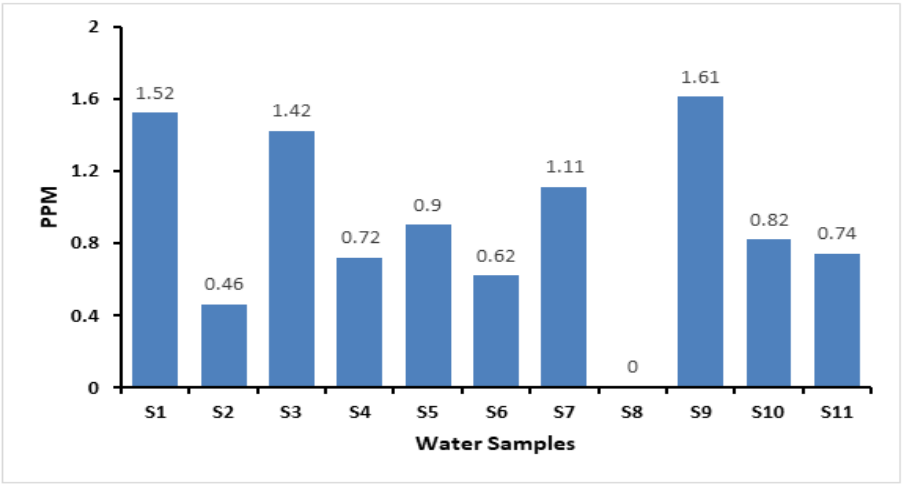

FIG.6. **Calcium from samples 1-11.**

Magnesium

Magnesium contents were lower than calcium ions in natural water and the presentvalues were below the permissible limits, less than 1 mg/L is an essential element in chlorophyll and in red blood cells. Greater than 125 mg/L concentrations have cathartic and diuretic effects. Calciumand Magnesium concentration refers to the water hardness. Both bond with carbonates and bicarbonates, alkalinity (Nitrates and Phosphates) and hardness are closely interrelated and produce similar measured levels. The hardness of water indicates water quality. Both Ca and Mg were less because they were collected during monsoon season. The values may vary depending on seasons (Figure 7).

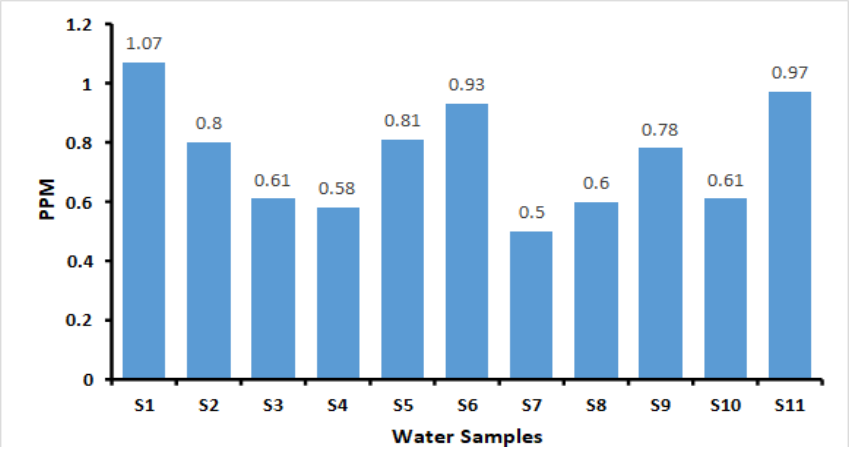

FIG.7. **Magnesium from samples 1-11.**

Potassium

Potassium is an essential element in both plant and animal nutrients and occurs in ground water as a result ofmineral dissolution. Potassium concentration in the present study varied from 0.29 ± 0.4 to 1.60 ± 0.10 mg/l of which higher value found in S2 and lowest in S4 respectively. Potassium remains in solutionform without undergoing precipitation (Figure 8).

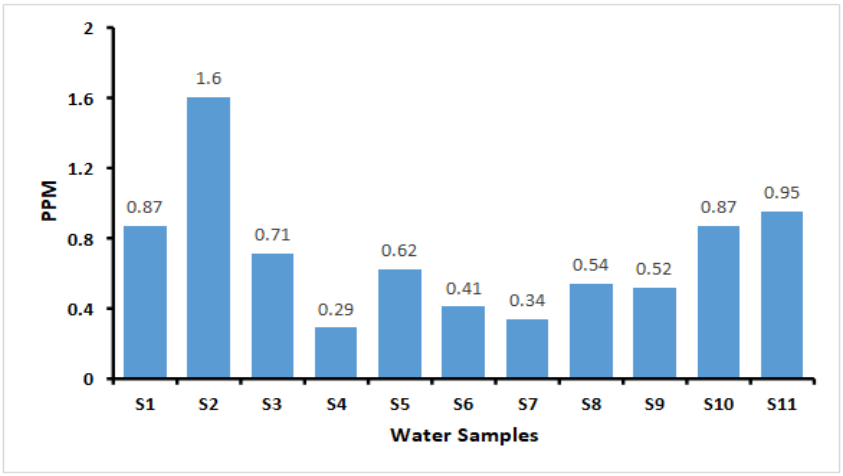

FIG.8. **Potassium from samples 1-11.**

Nitrate

The minor ions Nitrates, was high in S2 with 98 ± 2.0 mg/L and least value of 0.56 ± 0.04mg/L in S1 this range has no relaxation as already stated by WHO (HDL-50 mg/L and MPL-no relaxation). Minimum values of nitrate 12.6 mg/L and maximum of 21.2

mg/L has been reported earlier. Runoff and decomposition of organic matter is the main sources of nitrate in the water bodies. Unpolluted natural water contains usually only minute amount of nitrate (Figure 9).

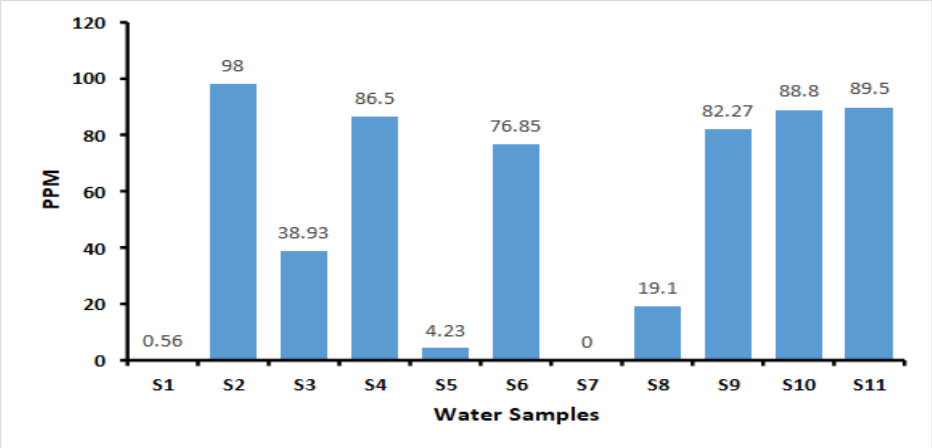

FIG.9. **Nitrate from samples 1-11.**

Phosphate

Phosphate is an essential nutrient for the plants and animals that make up aquatic food web. The results for phosphates value ranges from 0.03 to >2.0 mg/L. Minimum value of phosphate was 0.03 ± 0.003 in S5, S6, S9 and maximum value of phosphate was greater than 2.0 mg/L. in S2 and S10. The fluctuation of the values was due to the monsoon season, invaders, and organic matters or due to contamination of soil by anthropogenic activities by earlier reports (Figure 10).

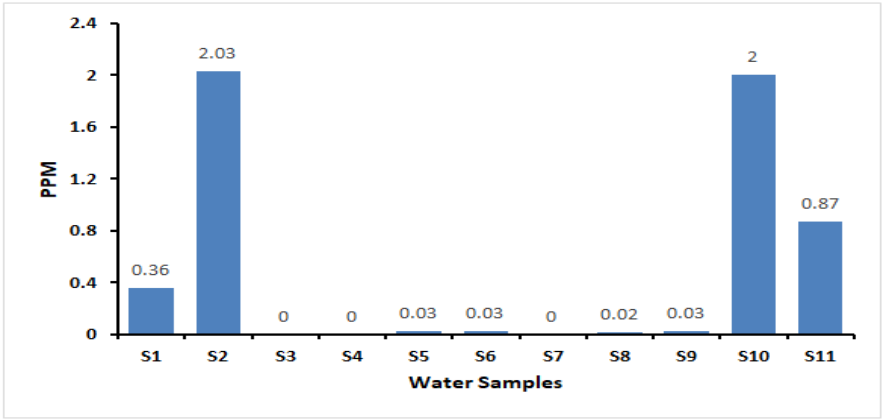

FIG.10. **Phosphate from samples 1-11.**

Dissolved Oxygen

In the present study DO was reported to be more in S7 with a value of 11.33 ± 0.04 mg/L and less amount in S2 of 3.2 ± 0.03 mg/L. S2 has DO value within the acceptable limits of 5 mg/L. This was due to waste discharges high in organic matter and nutrients near the pond site and also due to increase in degraded organic matter by microbial activities. Similar results were observed and reported from the selected water bodies. Temperature of water affects the quantity of DO in water directly or indirectly. Oxygen content is important for direct needs of many organisms and affects the solubility of many nutrients and therefore the periodicity of aquatic ecosystem. The principle source of oxygen in water is atmospheric air and photosynthetic planktons. Obtaining sufficient oxygen is a greater problem for aquatic organisms than terrestrial ones, due to low solubility for oxygen in water and solubility decreases with factors like increase in temperature, increase in salinity, low atmospheric pressure, high humidity, high concentration of submerged plants and plankton blooms. Dissolved oxygen reveals the changes occurring in

the biological parameters due to aerobic or anaerobic phenomenon and it signifies the condition of the river/streams water for the purpose of the aquatic as well as human life. The range of DO lies between 4 to 6 mg/L, which ensures better aquatic life in the water body (Figure 11).

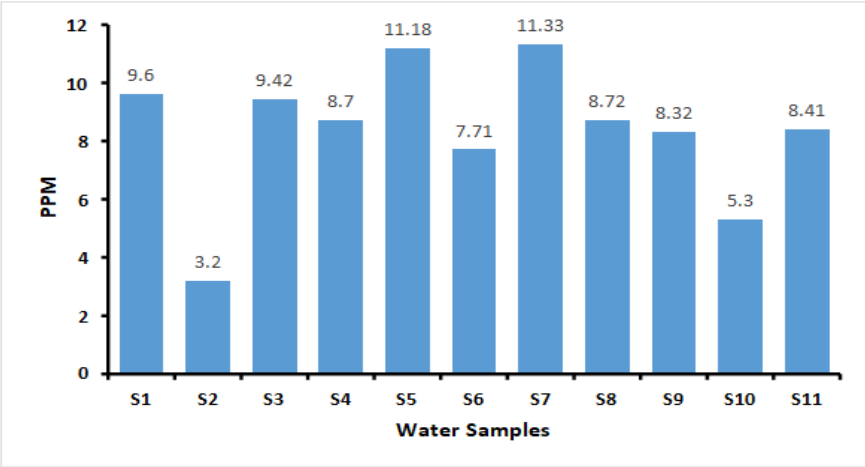

FIG.11. **Dissolved Oxygen from samples 1-11.**

Conclusion

The study has provided information on the evaluation of water quality from selected agriculture ponds in Yeswanthpura village, Malur taluk, Kolar district, Karnataka, India. These ponds have great potential as a means to capture and store rain water for irrigation; therefore it is essential to assess the quality of these water bodies as a crucial first step with regard to completing a comprehensive characterization of pond health, biodiversity and evaluating the suitability of pond freshwater for agricultural applications. There was a significant increase in nitrate and turbidity in some ponds this kind of changes would affect the aquatic environment as increase in nitrogen content would result in eutrophication naturally, which leads to decreasein the oxygen content level. The source for calcium, sodium, chlorine and other elements in the rain water harvested ponds might be due to the agricultural runoff as the amount of chemical pesticides and fertilizers have increased for better crop yield to satisfy crop demand. Each parameter correlates with the other influencing them in many different ways, thus the study recommends regular monitoring of the conditions of pond water and taking precautionary steps to ensure compliance with water quality standards and environmental regulations to maintain a healthypond.

Acknowledgement

We are thankful to Dr. Mahesh. M for his continuous scientific, research oriented moral support, AzymeBioscience Pvt. Ltd., Jayanagar, 9th Block Bengaluru-560069.

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