ALGAL BIO-INDICATORS AND ITS METHODS FOR ANALYSIS OF WATER QUALITY

Abstract

Algae is a diverse group of photosynthetic organism and its play a crucial role in aquatic ecosystem as primary producer and indicators of environmental health. In this chapter explores the significance of bioindicators by using algae and it's the quality of aquatic environments. Algae respond rapidly changes in water quality to various environmental stressors, making them valuable tools for monitoring ecosystem health. Algae role as bioindicators stems from their sensitive to factors such as nutrient concentrations, pollutants, temperature, pH, other physicochemical parameters. The application of algae as bioindicators involves both qualitative and quantitative analysis. Qualitative assessments involve identifying indicator species or groups that are indicative of specific environmental conditions. Quantitative measurements such as chlorophyll-a concentration, provide insights into nutrient enrichment and overall productivity. Therefore, the utilization of algae as bioindicators offers valuable insights into the helath and equilibrium of aquatic ecosystems. So, effective algae based bioindicator programs contribute to informed decision making for sustainable resource management and environmental conservation.

Keywords: Biondicators, Algae, Aquatic, Qualitative and Quantitative.

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I. INTRODUCTION

Water is the most important and largely irreplaceable many causes life such as health care, biodiversity conservation, food security, economic growth and environmental stability. Air, water, land, flora and fauna are the main elements of nature. These elements are interconnected and interdependent on each other. Deterioration in one element badly affects the other four elements. Organisms exist where there is an adequate source of water. All living organisms are composed of cells that contain at least 65 to 75 percent of water. Water is required for many human activities like drinking, cooking, bathing, sanitation, washing, agriculture, industries, recreation, navigation, fisheries etc. Water acquires about seventy percent of the world's surface area. However, about 98 percent of water is present in seas and 1.998 percent water is locked up in arctic ice caps, glaciers, mountains and clouds (Trivedy, 1995) only 0.00192% water is available for human being.

Marine water is with a relatively high percentage of dissolved salts such as sea and ocean. The water flows in the rivers, streams, canals are called lotic water whereas lentic water bodies are ponds, lakes, dams and other reservoirs. The Indian subcontinent is very rich in fresh water resources. Increasing developmental activities is affecting the quality of freshwater. A survey by NEERI shows that 70 percent of India's fresh water is polluted by conventional standards. Peoples commonly used fresh water for various agriculture and daily practises from lakes, ponds, pools, puddles, and manmade reservoirs.

In the reservoir, density is directly effects of water quality and phytoplankton diversity (microphytes). Phytoplanktons are microscopic, free floating algae. In stagnant water phytoplankton are dominant (Anand, 1975). The distribution and periodicity of phytoplankton is governed due to seasonal changes. The production of algae, in an aquatic ecosystem, tends to vary with variation in various physical factors. The Macrophytes play significant role like bio-indicators to improve water quality. It is an important characteristic of certain algae that they grow in specific quality of water. The functional integrity of aquatic organisms is characterized by aquatic algae, and the aquatic pollution index is analyzed by the biodiversity index, which is depend on the algae and its number.

Various water reservoirs are important and its water quality vary significantly due to different environmental conditions. High populations of micro-organisms present in water causes health hazards. Different manmade activities are responsible for deterioration of water quality. Physical, chemical, biological studies of the reservoirs are some aspects of hydrobiology. A number of hydrobiological studies are carried out on freshwater reservoirs in Maharashtra and India by Trivedy (1995), Goel *et al.*,(1985) and More and Nandan, (2001).

Aquatic plants are good indicators about the water quality. There is some report on the pollution status and water quality of various water reservoirs, Robert *et al.,* (1974); More and Nandan, (2000) and Bhatt and Patak (1992). The pollutants responsible for contamination aquatic bodies when the polluting components are directly or indirectly released into them. The entire biodiversity of living beings as affected due to pollution of water resources. Mostly pollution harmful effect is not only to individual species and population, but also to the natural biological communities. In eutrophication process there is increase in algal bloom because presence of nitrate and phosphate in the water. As a result, increase in algae and reduce other aquatic plants. On other hand reduced amount of sunlight to the bottom plants it leading to death. The Mass multiplication of algae and reduce sunlight some algae die and its degradation carried out by the bacteria. The oxygen released after degradation is taken by the algae so other aquatic organisms was dead.

Presently the scientist tries to monitoring water potential eco environmentally by chemical parameters and biological indicators. So it is very difficult to conclude the situation about the water quality without more assessment.

II. AQUATIC WATER BODIES

A water with surrounding terrestrial systems formed aquatic ecosystem. Marine, freshwater and estuarine are three main types of ecosystem, which are symbiotic relationship with the environment.

1. **Fresh water system:** The freshwater may be lentic, lotic and wetlands.
2. **Marine Water System:** The marine water system includes oceans; seas are the largest reservoirs. Which includes four types of ecosystems
3. Estuary is a coastal water body where combination of fresh and marine water together.

III. WATER POLLUTION

Generally, water quality is mostly depends for the human activities, local geology, ecosystem. Various aspects of algae as bioindicators of water pollution, limnological studies and usage of algae in classifying water bodies were done by Hosmani and Bharati (1982). Deore (1978) has worked on fresh water algae of Maharashtra. Deshmukh and Pawar (2000) studied the impact of irrigation on environmental geochemistry of ground water in Sangamner region. Pingle (1981) has studied algae of impoundment and streams. Various aspects of algae of Khadakwasla lake; rare members of *Chaetophorales* and interesting *Tetrasporales* were studied by Pingle (1988).

Plants which stand in water and grow either floating or submerged are considered as aquatic plants. Water reservoirs like drains, ponds, ditches, pits, marshes, puddles are rich sources of aquatic flora. Aquatic macrophytes are of considerable ecological and economical importance. They provide shelter to aquatic invertebrates, mobilize mineral elements fishes and phytoplankton. They are indicators of water pollution. Certain macrophytes are responsible for purification of waste water and minimize the water pollution. Aquatic macrophytes adversely affect water quality. Variation in dissolved oxygen during different seasons revealed that maximum values occur during winter and minimum during summer. The planktonic density and abundance of fresh water ecosystems has been studied by Hosmani and Bharati (1982), Hegade (1989) and Sharma (1988).

Phytoplanktons and physiochemical parameters are used as indicators of eutrophication and pollution, studies of reservoirs. Habib and Chaturvedi (1993), studied density and productivity of phytoplanktons and their relationships with the water quality. Gunale (1991) suggested the relationship of algal communities as indicators of water quality. When a water body receives pollutants, its physicochemical structure varies causing change in biota. Some organisms in water are sensitive to pollution, while others are tolerant.

Biological and physico-chemical parameters was help to find out water quality and it's also help to restoration maintenance and self-regulation of water quality (Singh *et al*., 2004).

IV. BIOLOGICAL INDICATORS

Biological indicators is a biological processes of any individual species or group are used to measure the quality of the environment. It is directly measures of health of the animals and plant in the waterways. Fresh water is commonly used as a biological indicators including several of algal diversity, micro-organism diversity, fish diversity and insects' diversity etc. In 2010, Akanksha Jain *et al*., reported two types of biological indicators. I) Accumulation bio-indicator means to pollutants store not any changes in their metabolisms; II) Response bio-indicator means to cell changes or damage of visible symptoms in small quantity of harmful substances. Responses bio-indicators again divided three type ecological, behavioral and physiological changes. Ecological changes is defined as the changes of population density of species and its diversity. Behavioral changes mean changes in web spinning, bacterial mobility or feeding activities. Physiological changes are called as an accumulation of heavy metal, BOD, microbial activity and CO2 production.

Bio-indicators is used as a collective type to referring all abiotic and biotic reaction ecosystems changes. The natural change of taxa are directly effects of environmental surrounding changes. It is used to natural surrounding changes and its negative or positive impacts referred by Trishala *et al*., (2016). Holt and Miller (2011) reported that presence of pollutant in the environment was directly effect on the biodiversity. So, overall use of Bio-indicator will help to regulate environment condition. Nkwoji *et al*., (2010) was also mentioned that biological indicators continuously integrate knowledge from the ecosystem. The macrophytes have their great potential to indicate quality of water as well as tolerate and accumulate high concentration of toxic substances (Caffrey *et al*., 2006). Chandra and Sinha, (2000) was reported in some susceptible species of aquatic plants metals responsible for the morphological and structural changes.

V. ALGAE AS BIO-INDICATORS

Bio-indicator species is useful in revealing information about their habitats and explain the characteristic of habitat through their population abundance of particular responses to the ecosystem. Didem Gokce (2016) reported that the utilization of bio-indicators is not just restricted to a single species with a limited ecological tolerance. Algae is one of the important bio-indicators to monitoring programs for evaluation of water quality due to their different characteristics. Algae is very good environment indicators which is directly effects on qualitative and quantitative characteristics. Composition of various species in a wide range of water situations is depends such as increases in water pollution due to involved in wastes of industrial and tolerate effect of the composition of genera. Hosmani (2013) observed that many algal species were successfully used by to indicate pollutant in aquatic ecosystems.

Dokulil (2003) and Jain et al., (2010) reported that some fresh water blue green algae and marine algae was also used as biological indicators for perceiving the changes in pH value in various ecosystems. Beaugrand *et al*.,(2000) was found that the bottom of the food chain in aquatic ecosystems, alterations to their numbers and diversity will affect the entire food web. Biological and physicochemical factors such as substrate, light, temperature competition vary among habitats. With time populations develop strategies to maximize growth and reproduction within a specific range of habitat conditions (Devlin *et al*., 2011).

VI. MACROPHYTES AND DIATOMS AS A BIO-INDICATORS

All over the world water is essential and important for survival and growth of plants and animals. Water is essential components in all living organism, those grow in water or terrestrial, without water not survival for any living organism. But, now days the presence of pollutants in the environment is usually linked to wastes from anthropogenic activities, oceans, rivers and lakes. The most common contaminants are heavy metals, because it is easily present in the Earth's crust, manufactured products and industrial wastes (Vareda et al.,2019). Menna et al., (2017) is reported that all these elements have directly impact on the environment and water bodies like reservoirs, lacks, rivers etc. For that reason, there is number of components, used to study quality of water.

The presence of aquatic macrophytes is main plants communities used as indicators for identification of water quality (Robach et al.,1996). Macrophytes are non-motile organisms effects on growth of aquatic system. Macrophytes are one of the four basic elements in the assessment of the ecological condition of rivers in addition to phytoplankton, macroinvertebrates and fish fauna (Gebler et al.,2014). The presence of plants like Eichhornia crassipes and Lemna minor have properties that make them potential bioindicators of heavy metals. It can accumulate and tolerate some metals (Bonanno et al.,2018). Bhatta and Patra (2020) mentioned that emergent macrophytes such as Typha angustifolia and Typha latifolia were observed in acidic waters. Pharagmites australis was observed in water of indifferent pH and Cyperus alopecuroides was also observed in the alkaline water. Some emergent species like *Carex riparia, Scripus lacustris* and *Pharagmites australis* were observed in rich NO3 and PO4 concentrations. *Ludwigia stolonifera* were found in alkaline, rich NO3 and moderate PO4 concentrations. Macrophytes function as long-term indicators with high spatial resolution (Drake and Heaney,1987).

Memon and Schroder, (2009) reported that, the macrophytes of some plant species more successful bio-accumlators for various elements and for this high potential in possible use as environment phytoremediators. Many researches recorded that macrophytes *Ranuculus* sp.., *Menta* sp., and *Rumex* sp. was potential for heavy metal removal. So, as per overall observation, it was observed that macrophytes and microphytes impact in heavy metals accumulation in aquatic ecosystems. There are many effective using of macrophytes as bioindication or biomonitoring with several advantages.

Diatom is belonging to class Bacillariophyceae and division Chromophyta. Nearly 16000 species found in all over the water of Earth. Diatoms are single celled organisms and microscopical algae. Diatoms sometimes used to identify changes in water quality depending on the ecological conditions. Diatoms is a small water bodies and is used as bio-indicators of quality water. Diatoms are one of the most diverse groups, where used as the assessment of the ecological state of water bodies (Poikane *et al*.,2016). Diatoms mostly found all types of superficial water. Diatoms are found in either planktonic or benthic or both depending on their habitats. Gonzalo and Fernandez (2012) mentioned that, the algal species that develop in an area depend on various environmental factors like salinity, water chemistry, etc.

VII. AGRICULTURAL IMPORTANCE OF ALGAE

Algae is play a major role of the food chain of aquatic life. They are food producer for many aquatic animals. As the algal growth and composition alters, it affects the web and food chain of aquatic ecosystem. Algae help to improve the soil fertility, soil reclamation, bio-controlling of agricultural pests etc. Soil fertility and nitrogen fixation is interrelationship with each other. Soil fertility is maintaining for algae species and they are directly effects on nitrogen fixation in the soil. Algae are used as human food with high amount protein contain present in there. Mostly spirogyra algal species highly used for food consumption for human being. Algae are used as medicine, textile, paper and paint industries, chemical extracts from larger marine algae.

Seaweeds is important microorganisms and it main agriculture biofertilizer and soil stabilizers for a long time. Craigie (2011) reported that Romans Columella and Palladius was used algal manure for the cultivation of vegetables and fruit plants. Sauvsarsu *et al*., (1920) reported some species are used to prepare the soil. Algae also used to feed for animals. *Alaria esculenta* and *Ascophyllum nodosum* species mostly called as cow algae and pig algae, respectively Sauvsarsu *et al*., (1920). Recently, Fleurence, (2022) mentioned that number of aquatic algae are used in agriculture for soil preparation or biostimulants. This biostimulants are considered to be different from fertilizers and it also used for induce plant growth in very small quantities. Algae is also promote seed germination and the growth of plants in vegetable.

VIII. METHODS OF ANALYSIS OF WATER QUALITY

Water is considered as life for living matter. Water contains variable quantities of dissolved solids, gases and suspended organic and inorganic materials. The quality of water decides soil health, crop condition and ultimately the human health. Water is classified as hard or soft, according to concentration of calcium and magnesium. Water is also called as carbonated, sulphated depending up on the concentrations. The quality of reservoir is governed by source of water, type of soil, topography of catchment area, flow of factory effluents and human interventions. In view of this, present chapter have to planned out that details about the procedure for collection of sample and methods of analysis water quality is a below.

1. **Collection of Water Samples and Analysis:** Study samples is mostly collected periodically in morning periods. Due care is taken while collecting the water samples. Samples were collected (1 Liter) from the study location and labelled properly. After, this sample is immediately brought for chemical or algal studies. Parameters used to access, quality of water like pH, total salts, cations, anions and total substances.

2. **Methodology for Physicochemical Analysis**

   The physicochemical studies is involved in various physicochemical parameter and its types. Details about all parameter and its types describe is in below.

   - **Temperature:** Water temperature was noted on field for each sampling location. Temperature plays important role in various other parameters like alkalinity, pH, D.O, TDS etc.

- **pH:** The pH value was noted with the help of pH meter. pH measured by taking 50ml. water sample. Before measurement, pH meter was standardized. The reading was noted from dial of pH meter.

- **Turbidity:** In water turbidity is a suspended matter and it offers obstruction to light passing through it. The greater the obstruction offered, greater is the turbidity of water. Turbidity was determined by Nephelomtric turbidemetric method (Trivedy and Goel, 1986). Nephelometer turbidimeter was set to 100 with 40 NTU standard suspension made form Hydraxine sulphate and hexamethylene teramine. Water sample (100 ml) was diluted to 200 ml.distilled water.

- **Dissolved Oxygen (Winklers Iodometric):** The oxygen present in water oxidizes $Mn(OH)_2$ to MnO_2. The Mn (4^+) produced in solution is determined idometrically. The Mn^2+ and alkali added to the water sample was oxidized by dissolved oxygen to MnO_2. The procedure is the help of Pipette out 100 ml of water sample in 250 ml conical flask. Add 2 ml of $MnSO_4$ solution and 2 ml of alkaline iodide Sodium azide solution by immersing pipette below the water surface. Shake the flask for 30 sec. and allow to precipitate. The precipitate allows to settle and add 2 ml of conc. H_2SO_4. Add 2 ml of starch indicator and titrate with 0.4 N standard Sodium thiosulphate solution till color end to milky white.

Determination of Cations

- **Calcium:** The di-sodium salt of EDTA forms strong complex with calcium is determined by using calcon indicator. 10% NaOH changes the colour of water from pink to blue. Record the volume of standard EDTA for calculating Ca^{2+} in water. The procedure is a Take 10 ml of water sample in 100 ml conical flask. Add 10 drops each of hydroxylamine hydrochloride: potassium ferrocyanide and triethanolamine. Add 10 ml of 10% sodium hydroxide. Titrate with standard EDTA solution by using 5 drops of calcon indicator, till pink colour changes to blue.

- **Magnesium:** Calcium and magnesium in water sample is titrated against standard EDTA using Erichrome black T (EBT) as indicator and NH_4Cl + NH_4OH as buffer till colour changes from wine red to sky blue. Then, the procedure is take 10 ml of water and add 5 ml of buffer solution. Add 10 drops each of hydroxylamine hydrochloride, Potassium ferrocyanide, TEA and 4 drops of EBT indicator. Titrate against standard EDTA till colour changes from wine red to sky blue.

- **Potassium and Sodium (Flame Photometric Method):** A sample containing potassium and sodium atomized in flame is burnt in the flame photometer. On burning potassium / sodium change their state of energy from ground state to excited state and again to ground state. While coming to ground state it emits a radiation of characteristic wave length (768nm). These wavelengths pass through filter. Falling on photocell, produce electron or generate electric current, it can be measured on dial of instrument.

- **Preparation of Standard Curve of Potassium:** 100 µg mL^{-1} Potassium solution, prepare standard solution 0, 2, 4, 6, 8 and 10 µg k mL^{-1}. A curve was drawn by plotting flame photometer reading on 'y' axis against concentration of potassium on 'X' axis. Atomize the sample, in preset flame photometer and record flame photometer reading. Dilute the sample and plot the potassium concentration from graph and multiply by dilution factor whenever necessary.

- **Sodium:** Standard sodium chloride (NaCl) solution prepared by using 100 µg m/C^{-1} Dissolve 5.845 g of sodium chloride (AR) in water and make the final volume 1000 ml. The Preparation of standard curve from the 100 µg Na mL^{-1} solution prepare the standard solution of 0, 2, 4, 6, 8 and 10 µg Na mL^{-1}. A curve was drawn by plotting flame photometer reading on 'y' axis against concentration of sodium on 'x' axis. Atomize the water sample in preset flame photometer and record the reading.

Determination of Anions

- **Determination of Chlorides:** Chlorides are small amounts found in in all natural waters. Mohr's titration method is mostly used for estimation chloride. Then, the formation of sparingly soluble brick red, silver chromate (Ag_2CrO_4) precipitation at the end point. After, sample is titrated against std. silver nitrate ($AgNO_3$) solution in presence of potassium chromate (K_2CrO_4) as colour indicator. Initially the Cl^- ions are precipitated as AgCl. dark brick red precipitation of Ag_2CrO_4 forms after the precipitation of AgCl. The procedure is the take 10 ml of water sample, add five drops of K_2CrO_4 indicator and titrate with standard $AgNO_3$ (0.02N) solution, with continuous stirring till the brick red colour appears.

- **Determination of Sulphate:** Trace of sulphate occurs in all natural waters. Its content can be found in most saline waters, showing EC more than $1dSm^{-1}$ ($25^0{}_C$). Sulphate ions are precipitated as barium sulphate crystals of uniform size in acid medium. Light absorbed by the precipitate, is measured at 340 nm by spectrophotometer.

  - **Determination of Carbonates and Bicarbonates:** Carbonates and bicarbonate in the sample can be determined by titrating with standard sulphuric acid by using phenolphthalein and methyl orange as an indicator. Addition of phenolphthalein gives pink red colour in presence of carbonates. Titrated with std. H_2SO_4 to converts CO_3^{2-} into HCO_3^- and decolorize the pink red colour.

$$H_2SO_4 + 2CO_3^{2-} \longrightarrow 2HCO_3^- + SO_4^{2-}$$

Methyl orange indicator was added to solution which gives yellow colour. Further, titrated with H_2SO_4 to neutralize all HCO_3^- in to $H_2O + CO_2$. Colour changes from yellow to rosy red.

$$2HCO_3 + H_2SO_4 \longrightarrow 2H_2O + CO_2 + SO_4^{2-}$$

Take 10 ml of sample in 100 ml conical flask. Add 3 drops of phenolphthalein, pink colour appears. Titrate against standard H_2SO_4 till colour disappeare. Burette reading is designated as ‘Y’ ml to this add 3 drops of methyl orange. Again titrate with standard H_2SO_4 till colour charges from yellow to orange red. Record the reading of standard H_2SO_4 as ‘Z’ ml.

- **Nitrates:** Nitrate was estimated by phenol disulphonic acid method (Trivedy and Goel 1986). For estimation, 50 ml sample is evaporate to dryness and extract with phenol disulphonic acid. After adding ammonium hydroxide, sample was made to 50 ml simultaneously standards were made by using $NaNO_3$ and colour was compared in Nasser cylinders.

- **Electrical Conductivity (Total Salts):** Electrical conductivity is directly proportional to its dissolved mineral matter content. Take 100 ml sample for the determination of electrical conductivity. The electrode of electrical conductivity meter was immersed in water. The conductivity was read on dial of instrument. The unit for electrical conductivity is dSm^{-1}

- **Free Carbon Dioxide:** Treat carbonized water with sodium hydroxide to from sodium carbonate. Sodium carbonate titrated with standard NaOH by using phenolphthalein indicator till water turns to pink. Take 100 ml of sample in 250 ml conical flask and titrate with standard NaOH by using phenolphthalein indicator. Till colour changes to pink.

- **Total Alkalinity:** The alkalinity of water is neutralized by titrating with the Std. HCl by using phenolphthalein as indicator till colour changes from pink to colourless.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2CO_3$$

Take 50 ml of water sample in 250 ml conical flask. Titrate with std. HCl by using phenolphthalein indicator till colour changes from pink to colourless. Record the volume of HCl required for titration.

- **Total Dissolved Solids (TDS):** TDS was determined by evaporation method (APHA 1985). For TDS assessment, filter the 50 ml of water sample through Whatman No. 1 filter paper. The residue on filter paper was dried in oven at 180^0C. The increase in weight over the empty dish gives total dissolved solids.

- **Biological Oxygen Demand (BOD):** The biological oxygen demand (BOD) is the amount of oxygen required by bacteria, algae and other microorganisms for stabilization of decomposable organic matter under aerobic conditions. The quality of oxygen required for the stabilization is taken as a measure of decomposable organic matter. The sample of water or an appropriate dilution is incubated for 5 days at 20^0C in the dark. The reduction in dissolved oxygen concentration during the incubation period yields a measure of the biological demand. For BOD practical implementation with used Phosphate buffer Manganese sulphate solution, Magnessium sulphate, Alkali Iodide azide solution, Ferric Chloride solution,Conc. H_2SO_4, Calcium chloride solution, Sodium thiosulphate (0.025N) and Starch indicator this are reagents.

The practical completion there is used various process and method all detailed are the following. Distilled water sample is aerated with supply of clean compressed air, for 20-30 min. Add 1 ml each of phosphate buffer, ferric chloride, calcium chloride and magnesium sulphate solution to 1 lit of distilled water as micronutrients for bacteria.

The following dilutions were made (i) 0.1 to 10 % for strong treated sample (ii) 1 to 5 % for raw sample (iii) 5 to 25 % for oxidized sample (iv) 25 to 100 % for polluted river waters. Prepare the desired dilutions by adding sample in the distilled water. Fill up one 300 ml BOD bottle with mixture and other with dilution water (blank) in two sets. Keep one set in BOD incubator for 5 days incubation at 20^0C and find out immediately dissolved oxygen of blank and sample bottle. Find out Dissolved oxygen in both the bottles incubation of 5 days.

BOD mg/L = $(D_1-D_2) – (B_1-B_2)$ X dilution factor.

- **Biological Studies:** The reservoirs were screened for different forms of algae. The samples were observed on the spot in natural conditions. Part of the sample was preserved in 4% formalin solution and Lugol's solution for detail studies in the laboratory. Samples were collected using plankton net, of mesh size 20. The macroscopic algae were collected in bottles and polythene bags

  - **Algal Analysis:** The reservoirs were studied for different forms of algae. Periodical collection has been done from sampling locations. The fresh as well as preserved algal forms were observed under research microscope. They were identified with the help of standard literature and monographs.
  - **Macrophytes:** Macrophytes, aquatic, were collected and photographed around study sites. They are identified with the help of Cooke's flora (Cooke,1967). Some macrophytes were noted as possible indicators of water quality.
  - **Statistical Analysis:** Statistical analysis has been done, by correlation between physico-chemical parameters and phytoplankton of groups. Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Euglenophyceae, (Pansey and Sukhatme 1967). The correlation coefficient values were found as, no correlation (0), negative correlation (-ve), low correlation (upto 0.3), medium correlation (upto 0.5) and high correlation (upto 1).
  - **Pollution Studies:** Pollution studies of the reservoirs, has been made with the help of pollution index studies, i.e. Palmer (1969) pollution index and trophic state indices (Nygaard's, 1949).

3. **Palmer's Pollution Index:** Palmer (1969) has developed, algal pollution indices based on genus and species rating of water samples. It includes pollution tolerant genera and species of algae. Most frequent 20 genera were considered. The pollution index was calculated for all sampling locations. The numerical values for individuals are as follows. 0-10: Lack of Pollution,10-15: Moderate pollution,15-20: Probable evidence of high organic pollution,20 or more: High organic pollution.

4. **Nygaard's Algal Indices:** Nygaard's (1949) algal indices were used to determine trophic states of all sampling locations. These indices are used to determine the water quality of

water. These values are used to categories of algae for oligotrophic and eutrophic condition followed according to Niggard (1949).

IX. CONCLUSION

Algae is one of the important plant organism present in semi and semiarid region. Algae is mainly divided into two major types of macroalgae (seaweeds) and microalgae. It is distributed throughout the fresh water and marine water grown as phytoplankton. Number of types of colours algae observed in all over the word like.green, red, brown and yellow , due to different environmental condition and huge number of pigmented algae cell. Algae is main aquatic food chain in these ecosystems on the base of phytoplankton. It also play an important role in organic carbon production and nutrient cycle. Algae are also used as for bio-indicator for water quality identification and assessment. There is number of algal blooms species indicators to identify, clary known about quality of water. Algae is also used for agriculture system. Number of Bio-fertilizers were prepared by using various algae species. Soil fertility and to control the water pollution thought out the year in the all over world and its beneficial for living organism. We suggest that future studies should focus for cultivation algal farming and awareness about algal importance for living organism.

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