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Seasonal Studies in Physico–Chemical Parameters of Mandapam, Thoothukudi and Kanyakumari Coastal Waters along South East Coast of India

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ABSTRACT

The present study was carried out to determine the Physico-chemical variations in coastal Waters of Mandapam, Thoothukudi, and Kanyakumari along the south east coast of India. The sampling of coastal water was carried out during April 2013 to March 2014.The environmental factors viz. temperature, salinity, pH, dissolved oxygen, inorganic nitrite, nitrate, phosphate, silicate, and chlorophyll -a were analyzed in the coastal waters. The Physico-chemical parameters have showed substantial and spatial variations. Physico-Chemical parameters can determine the species diversity and abundance in the particular area. Nutrient concentrations were higher during monsoon season and low during summer. Knowledge of nutrients relating to their influential sources, utilization levels and their availability will be of great value to assess the output potential of marine ecosystem.

Introduction

The coastal ecosystem gives us food and other resources, also used for waste disposal, recreation and inspiration. The environmental parameters of coastal areas are very important, because the variations in the Physico-chemical properties, such as temperature, salinity, pH, dissolved oxygen and nutrients influence the biotic life cycles [1]. Deviations in the nutrients affect the activities and growth of the organisms in the ecosystem [2]. The distribution and activities of nutrients in the coastal environment, particularly in the near-shore waters and estuaries, exhibit considerable deviations depending upon the local conditions such as rainfall, the quantum of fresh water inflow from land, wave action and also biological activities including phytoplankton uptake and regeneration[3][4]. Considering the importance of the role of Physico-chemical parameters on the productivity potential of coastal waters, numerous studies have made in the coastal waters of India to relating to their seasonal impacts [5] [6]. During the last century, great concern and attention had given to the impact of human activities along the coastal ecosystems [7]. Among the several water quality characteristics, the most important parameters such as temperature, pH, dissolved oxygen, electrical conductivity, total dissolved solids, total suspended solids, biological oxygen demand, chemical oxygen demand, nutrients (phosphate, silicate, nitrate and nitrites) and heavy metals would play a substantial role in the life of the aquatic organisms [8]. Monitoring activities of coastal ecosystems gives us the importance and understanding of the past processes, present ranges and future paths in aquatic organism's health [9]. If the supply of nutrients is less than the uptake by organisms, nutrient concentrations decrease and limit additional growth of phytoplankton that the nutrient concentrations varies with the seasons, location and phytoplankton community [10][11]. Nitrates, silicates and phosphates are the important nutrients for the growth of aquatic organisms. So, in the present study, shows the effect of Physico-chemical parameters of coastal waters along the coastal areas (Mandapam. Thoothukudi, Kanyakumari) of South East Coast of India. The result shows some abnormalities in the Physico-chemical quality of water during the Pre-Monsoon, Monsoon, Post-Monsoon and summer seasons.

Description of the Study area:

The study area Mandapam (latitude 9°16'14"N; longitude 79°7'10"E), Thoothukudi (latitude 8°46'26"N; longitude 78°10'9"E), Kanyakumari (latitude 8°4'45"N; longitude 77°32'38"E) are located along the South East Coast of India. Mandapam is situated close to Gulf of Mannar Biosphere. Thoothukudi situated along south part of the East coast of India, having many industries located along the seashore and having a major Port. Kanyakumari (formerly known as Cape Comorin), lies at the southernmost tip of East coast of India. (Figure 1).

Figure 1. Sampling Locations and Sampling Points

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Materials and Methods

Temperature (surface and water) was measured using a standard centigrade mercury thermometer. Salinity was measured with the help of a Digital Refractometer PR-100SA (ATAGO) and seawater pH was measured using HACH portable pH meter. Dissolved oxygen was estimated by the modified Winkler's method. For the analysis of nutrients, surface water samples were collected in clean polyethylene bottles, kept in an ice-box, and transported immediately to the laboratory. The water samples are filtered through the Millipore filtering system (MFS) for required filtered sample. The Nitrite, Nitrate, Reactive Silicate and Ammonia by adopting the standard methods described by Strickland and Parsons (1972) [12], using SHIMADZU (UV-2600) UV-VIS Spectrophotometer.

Monthly variations of Physico -chemical parameters viz., temperature, salinity, pH, dissolved oxygen, nitrite, nitrate, ammonia, total phosphate, reactive silicate and Chlorophyll -a are recorded from April 2013 to March 2014. Based on the cyclic phenomena of meteorological events, four seasons are broadly indicated as month wise and they are (1) Post -Monsoon (January to March) (2) Summer (April to June) (3) Pre-Monsoon (July to September) (4) Monsoon (October to December).

Temperature

Atmospheric temperature ranges were 28.0-35.5 (°C) respectively (Figure 2). The surface water temperature influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling, mix up with ebb, and flow from adjoining neritic waters [13]. During the present study, sea surface water temperature varied from 25.2 – 33.2 (°C). The minimum (25.2ºC) was recorded at Mandapam during Monsoon and the maximum (33.2ºC) was observed in summer season at Thoothukudi coastal waters (Figure 3). Temperature fluctuations are mainly affecting the marine organisms. In the present study, high temperature in summer and low temperature during monsoon season were noticed. The water temperature during Monsoon Period was low because of strong land breeze and rainfall and the recorded high value during summer due to high solar radiation and less rainfall [14].

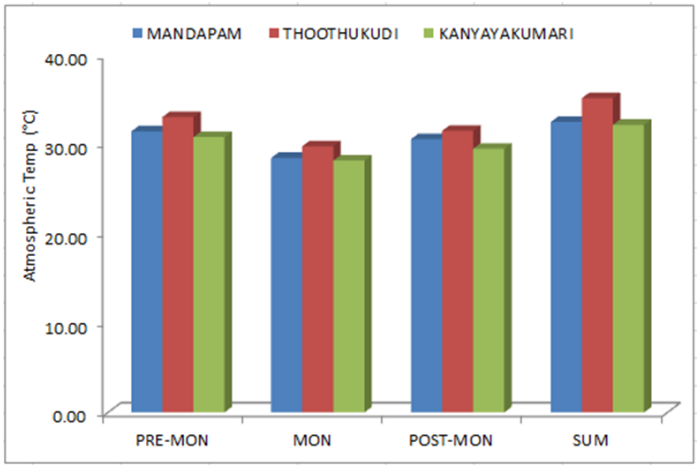

Figure 2. Atmospheric Temperatures at Different Seasons (April 2013 - March 2014)

Salinity

Salinity considered as the second important physical phenomena of the marine environment. Salinity acts as a limiting factor in the distribution of living organisms and its variation caused by dilution and evaporation is most likely to influence the faunal distribution. [15]. Variations in salinity affect fauna of the coastal areas and determine the sequence of species.

In the present study, the salinity was ranged from 32.10(‰) to 35.87 (‰). The minimum 32.10(‰) was recorded during Monsoon season at Mandapam and the maximum 35.87(‰) was observed in summer season at Kanyakumari Coastal waters (Figure 4).

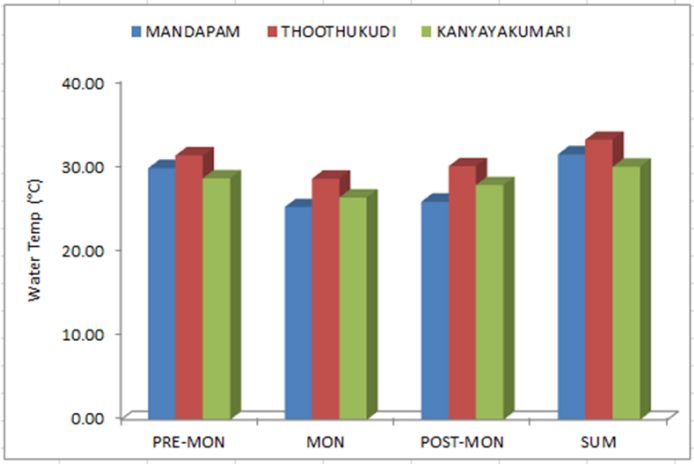

Figure 3 . Water Temperature at Different Seasons (April 2013 - March 2014)

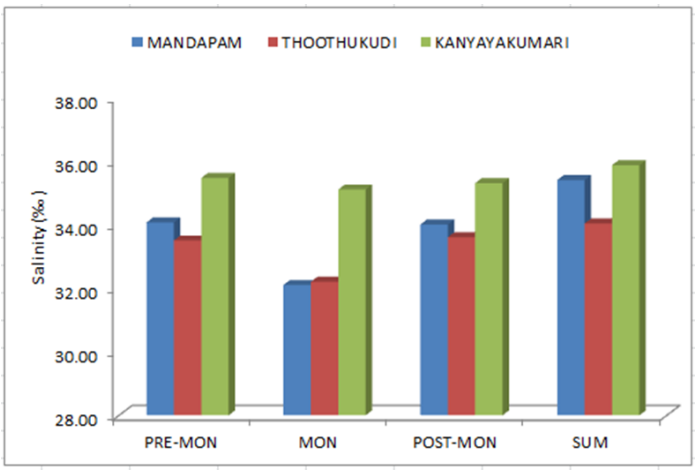

Figure 4. Salinity at Different Seasons (April 2013 - March 2014)

The salinity was found to be high during summer season and low during the monsoon season at all the stations. The recorded higher values (35.87%) may be due to the low amount of rainfall, higher rate of evaporation and also due to neritic shallow water dominance [16][17]. During the monsoon season, the rainfall and the freshwater inflow from the land in turn moderately reduced the salinity [18]. So fluctuations in salinity may be influenced due to rainfall and monsoonal flood. In the present study, salinity in all the stations was high during summer and low during the monsoon season.

Hydrogen ion Concentration (pH)

The pH of the coastal seawater normally falls between 7.8 and 8.3 and controlled by the buffering action. Generally, temporal fluctuations in pH caused by the factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, low primary productivity, reduction of salinity and decomposition of organic matter due to temperature[19]. In the present study, pH ranges from7.73 to 8.25. The minimum (7.73) was recorded in Kanyakumari during Monsoon and the maximum (8.25) was observed in Thoothukudi during the summer season (Figure 5).

The recorded high summer pH values might be due to the influence of seawater penetration and high biological activity and also due to the occurrence of high photosynthetic activity [20].

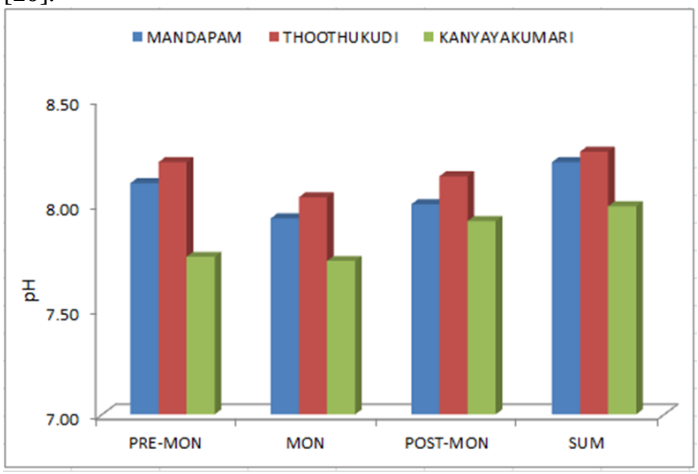

Figure 5. Hydrogen Ion Concentration (pH) at Different Seasons (April 2013 - March 2014)

Dissolved oxygen

The dissolved oxygen is very essential for the respiratory metabolism of all aquatic organisms. It favors the stability and availability of nutrients to the organisms. Therefore, it increases the productivity of the ecosystems. Commonly the dissolved oxygen content in the water samples depends on the temperature and seasons. In the study areas, Dissolved oxygen varied between 4.38 to 5.70 mg/l .It was found minimum (4.38 mg/l) at Thoothukudi during summer season and maximum (5.70 mg/l) at Mandapam during monsoon period (Figure 6). Due to the greater solubility of oxygen in water takes place when temperature and salinity are low, so the higher values occurred during the monsoon [21]. The surface water was usually oversaturated with oxygen during monsoon season, because the over entry of freshwater from estuary and Land run-off due to rainfall. It is well known that salinity affects dissolution of oxygen in seawater [22]. Higher dissolved oxygen concentration observed during the monsoon season might be due to the swelling effect of higher wind velocity joined with heavy rainfall and the resultant freshwater mixing [23].

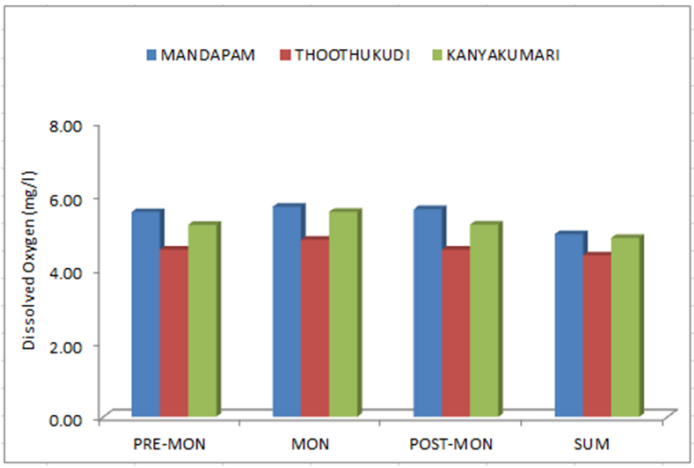

Figure 6. Dissolved Oxygen at Different Seasons (April 2013 - March 2014)

Nutrients

Nutrients are important parameters in the coastal Zones influencing growth, reproduction and metabolic activities of biotic components. Distribution of nutrients is mainly based on season, tidal conditions, freshwater inflow and land runoff, chemical, and petrochemical, effluents and flushing of fertilizer used in agricultural fields. Behavioral and distribution of nutrients such as nitrate, nitrite, phosphate and silicate in the coastal waters would exhibit considerable seasonal variations depending on the local conditions of rain fall, quantum of freshwater in flow, tidal invasions and nutrients consumption by phytoplankton biomass and regeneration. Low concentration of nutrients observed during the summer season may perhaps, due to a decrease in fertilizer waste disposal from the terrestrial region and consumption of nutrients by phytoplankton biomass [24][25]. Seasonal fluctuations of nutrients had been reported in coastal zone [26]. During the present study, all the four nutrients were found to be high during monsoon season and low during summer at both the stations.

Dissolved Inorganic Nitrite

The dissolved inorganic nitrite concentration values ranged from 0.41 to 1.53 µM/l. It was found minimum (0.41µM/l) Thoothukudi during summer and maximum (1.53 µM/L) in Kanyakumari during Monsoon season (Figure 7).

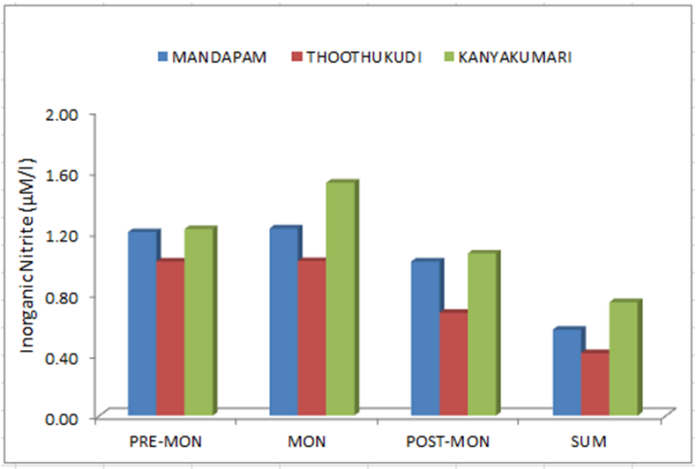

Figure 7. Dissolved Inorganic Nitrite at Different Seasons (April 2013 - March 2014)

The higher value of nitrite recorded during monsoon season could be due to variation in phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and bacterial decomposition of planktonic waste and also due to denitrification and air-sea interaction exchange of chemicals [27][19] . The recorded low value during summer and post monsoon seasons could be related to less freshwater inflow and high salinity [28].

Dissolved Inorganic Nitrate

The dissolved inorganic nitrate concentration values ranged from 5.00 to 14.20 µM/l. It is found minimum (5.00µM/l) at Thoothukudi during summer and maximum (14.20 µM/L) in Kanyakumari during Monsoon season (Figure 8).

The recorded highest nitrate value (14.20 µM/l) could be mainly due to the organic materials received from the catchment area during ebb tide [29]. The increased nitrate level may be also due to leaching of rocks, fertilizer, or other industrial discharge, domestic and municipal sewage, and fresh water inflow and mangrove litter-fall decomposition during northeast monsoon [30].

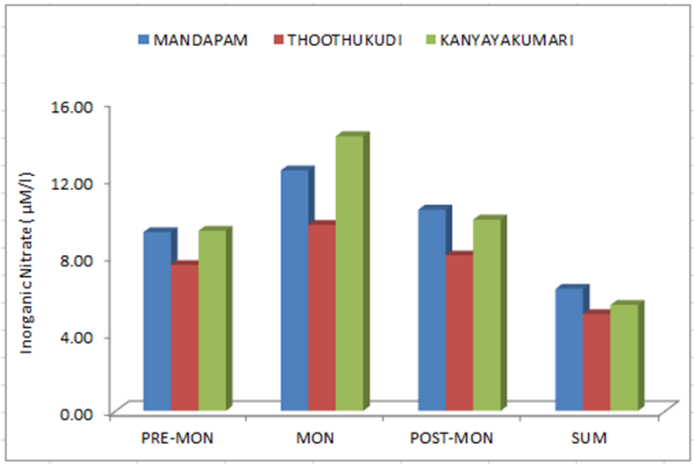

Figure 8. Dissolved Inorganic Nitrate at Different Seasons (April 2013 - March 2014

Another possible way of nitrate input could be through oxidation of ammonia form of nitrogen to nitrite and then consequently to nitrate [31]. The recorded low values (5.00 µM/l) during non-monsoon period may be due to consumption by phytoplankton as evidenced by high photosynthetic activity and the dominance of neritic shallow seawater having negligible amount of nitrate [13]. In addition, the low nitrate recorded during summer and pre-monsoon seasons may be due to less freshwater inflow and high salinity [32].

Dissolved Inorganic phosphate

In the study areas, the dissolved inorganic Phosphate concentration values ranged from 0.66 to 4.05 µM/l. It is found minimum (0.66 µM/l) Thoothukudi during summer season and maximum (4.05 µM/L) in Kanyakumari during Monsoon season (Figure 9).

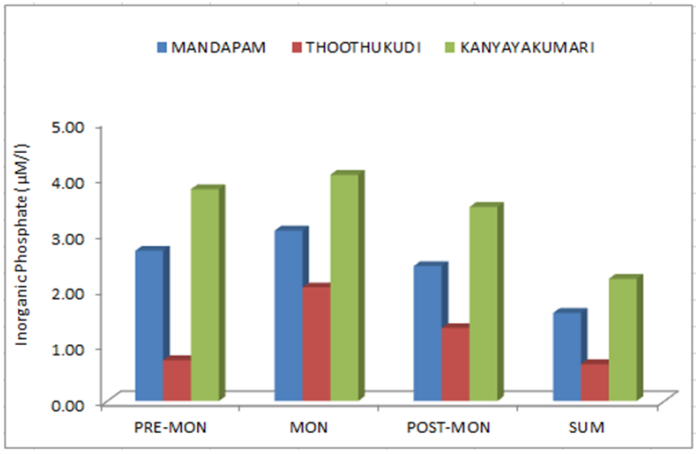

Figure9. Dissolved Inorganic Phosphate at Different Seasons (April 2013 - March 2014)

The high concentration of inorganic phosphates during monsoon season might be due to the monsoonal input. The low phosphates value during summer and post monsoon seasons could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton [33]. The variations may also be due to the processes like adsorption and desorption of phosphates and buffering action of sediment under varying environmental conditions [19]. Further, the recorded high monsoonal value may be due to heavy rainfall, land runoff, and weathering of rocks in the upstream area [13]. The addition of super phosphates applied in the agricultural fields as fertilizers and alkyl phosphates used in households as detergents can be other sources of inorganic phosphates during the season [34].

Reactive silicates

The dissolved inorganic nitrate concentration values ranged from 8.08 to 37.97 µM/l. It is found minimum (8.08 µM/l) Thoothukudi during summer and maximum (37.97 µM/L) in Kanyakumari during Monsoon season (Figure 10).

The silicate content was higher than that of the other nutrients and the recorded high monsoon values could be due to heavy influx of freshwater derived from land drainage carrying silicate leached out from rocks and also from bottom sediments exchanging with overlying water due to the turbulent nature of water in the estuaries [35]. Besides, the dissolution of particulate silicon carried by the river, the removal of soluble silicates by adsorption and co-precipitation of soluble silicon with organic humus compounds are also the reason for the depletion of silicate in summer season [19]. The decline in silicate level during summer can be reasonably due to its utilization by phytoplankton and bottom algae for their biological activity. Part of silicate content may have been lost to the bottom on mixing with sea water [36].

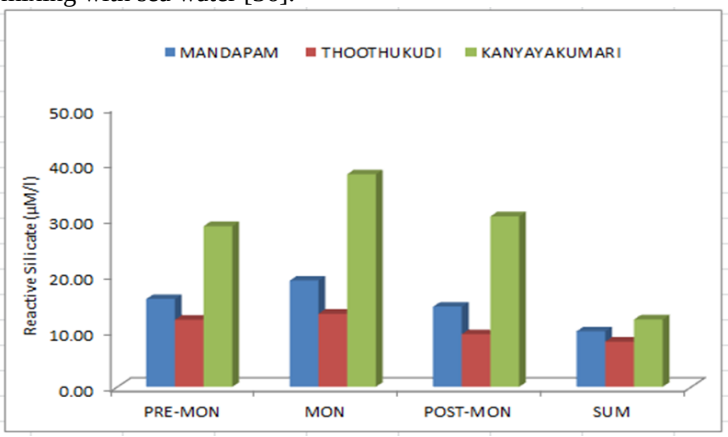

Figure 10. Reactive Silicate at Different Seasons (April 2013 - March 2014)

Ammonia

In the study areas, the concentration of ammonia ranges from 0.70 to 6.16 (µM/l). The possible sources of ammonia input into the waters could be from land runoff, zooplankton excretion, or demineralization of organic matter [37]. It was observed that the lower values of ammonia (0.71 µM/l) at Mandapam during summer season and higher value (6.16µM/l) was found at Thoothukudi coastal waters during Monsoon (Figure 11). The higher ammonia concentration was observed during the monsoon season and the lower values were found during the summer season in all stations. The recorded higher concentration could be partially due to the death and subsequent decomposition of phytoplankton and also due to the excretion of ammonia by planktonic aquatic organisms [38].

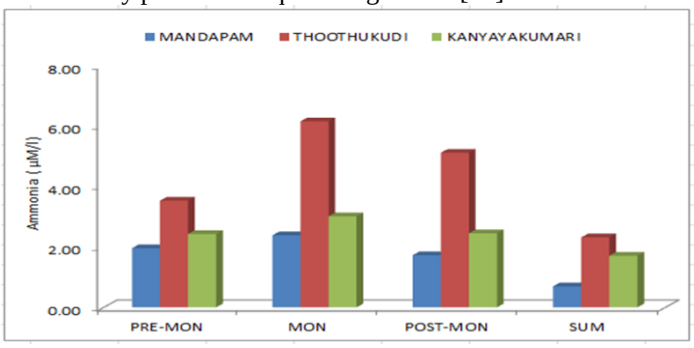

Figure 11. Ammonia at Different Seasons (April 2013 - March 2014)

Chlorophyll -a

Chlorophyll -a is the prime photosynthetic pigment essential for the primary production in the marine ecosystem. In the study areas, the Chlorophyll -a concentration values ranged from 2.09 to 15.05 mg/m3. It is found minimum (2.09 mg/m3) at Kanyakumari during Monsoon and maximum (15.05 mg/m3) also at Kanyakumari during summer season (Figure12).

High concentration of chlorophyll -a due to high values of phytoplankton production [39]. The higher value of chlorophyll-a was recorded during summer and the lower value was observed during monsoon. The low value in monsoon may be due to anthropogenic effects as evidenced by salinity and may also be due to freshwater discharges from the rivers, causing turbidity and less availability of light [40][41]. Its maximum and minimum concentration can reflects the physical and chemical characters of the environment and also important to study water quality and marine pollution.

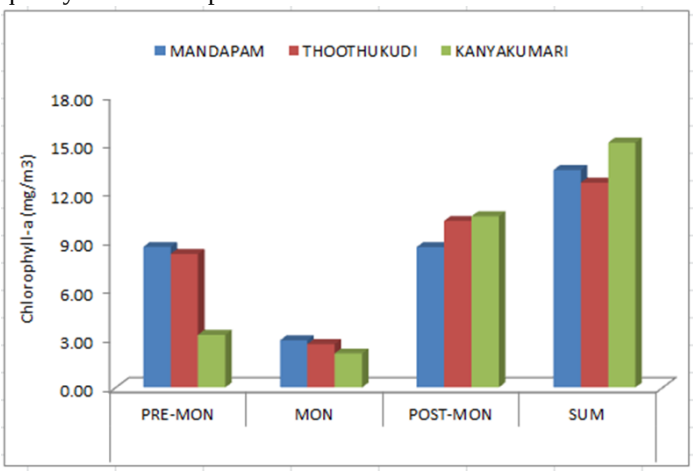

Figure 12.Chlorophyll-a at Different Seasons (April 2013 - March 2014)

Conclusion

The Physico-chemical condition of the coastal waters of Mandapam, Thoothukudi, and Kanyakumari coast, in general it is in good quality. In the two areas (Mandapam & Kanyakumari), the water quality parameters are not very much varied. However, the present study reveals some variations in coastal water of Thoothukudi; it may be due to effluent and anthropogenic discharge from the surrounding environment.

The present study shows that surface temperature, and pH has smaller variation in all seasons. Salinity was found to be low along the monsoon season; it is due to the runoff & large amount of fresh Water input from land during the northeast monsoon.

High Dissolved Oxygen values during the monsoon season, is due to low temperature and higher wave-tide action which dissolve the atmospheric air. The nutrients (Nitrate and nitrite, phosphates, Silicate) was found to be slightly varied in all seasons, it due the seasonal fluctuations.

A marginal increase in chlorophyll-a was observed during the post- monsoon and maximum concentration in summer, which could be due to dominant saline conditions during that period.

The variation in Physico-chemical parameters mainly depends on monsoon rains. The fluctuations in Physico-chemical parameter influence the natural activity and efficiency of marine organism and ecosystems.

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