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EVALUATION OF PHYSICOCHEMICAL PROPERTIES OF WETLAND WATER AT KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN INDIA

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ABSTRACT

Keoladeo National Park (KNP) is a 29 km2 area situated on the extreme western edge of the Gangetic basin that was once confluence of Rivers Gambhir and Banganga in Bharatpur district in the State of Rajasthan. KNP is part of the Indo Gangetic plain with elevations ranging from 173-176 meters above sea level. The major submersible area is around 8.5 square kilometer. The physicochemical parameters of KNP's water samples were analyzed for a period of three year from May 2006 to April 2009. The water samples collected were analyzed, as per standard methods. Parameters such as pH, inorganic phosphate, organic carbon, total nitrogen, sodium, potassium and calcium were measured. Statistical analysis was done with the help of Graph pad prism Software. All the results were shown as Mean ± SEM. Values were statistically significant at P< 0.05 and P<0.0001.

Keywords : *KNP, Physico-chemical analysis, Statistical analysis, Bharatpur, Keoladeo National Park*

साराँश

केवलदेव नैशनल पार्क (राजस्थान) के पानी के नमूनों का तीन वर्षों तक विश्लेषण संबंधी अध्ययन किया गया। पी–एच, इनऑरगेनिक फोस्फेट, ऑरगेनिक कार्बन, सम्पूर्ण नाइट्रोजन, सोडियम, पोटैशियम तथा कैल्शियम का मूल्यांकन किया गया है और इनकी सांख्यिकीय विश्लेषण का अध्ययन किया गया है।

Introduction

Keoladeo National Park (KNP), the site of the present study, is a designated Ramsar site and also a world heritage site. Since, no study has so far been conducted on the microbial aspect of the Keoladeo National Park; the present study was therefore conducted to have an insight of the physico-chemical properties of water which support microbial biodiversity of KNP. KNP is part of the Bharatpur district, has a population of 1.6 million, and extends over 5,084 square kilometers (175 times of KNP). The district town, Bharatpur, is about 2 km from the Park and about 15,000 people leave in 21 villages surrounding the Park. KNP (27º7'6"N – 27º 12'2"N and 77º 29'5" E – 77º 33'9"E) is a 29 km^2 area situated on the extreme western edge of the Gangetic basin that was once confluence of Rivers Gambhir and Banganga in Bharatpur district of the state of Rajasthan. KNP is part of the Indo Gangetic plain with elevations ranging from 173-176 meters above sea level. The major submersible area is around 8.5 square kilometer. The park has its origin from a natural depression (a fading away rain fed wetland). Ajanbund, a temporary reservoir near the park was constituted around 250 years ago, and the constitution of Ajanbund led to increase in human activities (Vijayan, 1991). Many outside people know the KNP as "Ghana" (meaning-dense forest) and among the local people it is known as Bharatpur bird sanctuary. The name Keoladeo is after Lord Shiva. There is a famous temple inside the Park. KNP has a unique mosaic of habitats that include wetlands, woodlands, scrubs, forests, grasslands that support an amazing diversity of both plant and animal species.

Vijayan (1991) in his report has included quite a bit on the chemistry of park water, flora, fauna and primary productivity of the park. Nevertheless, a systematic study on microbial flora of the park was recommended and was necessarily needed. The poor rainfall and inadequate water supply from the Ajanbund led to a drought condition inside the park and therefore the whole aquatic area of the park has become completely dried and appeared as open grassland during the period of visit and study (August 2006 – November 2007).

The area consists of a flat patchwork of marshes in the Gangetic plain, artificially created in the 1850s and maintained ever since by a system of canals, sluices and dykes. Normally, water is fed into the marshes twice a year from inundations of the Gambira and Banganga rivers, which are impounded on arable land by means of an artificial dam called Ajanbund, to the south of the park. The area is flooded to a depth of 1-2 m throughout the monsoon (July-September), after which the water level drops. From February onwards the land begins to dry out and by June only some water remains.

Attempts by earlier authors have been mainly focused on floristic components (Singh et al, 2009) of the Keoladeo National Park but as far as we know a comprehensive treatise on environmental factors has not been studied. The interactions of physical, biological and chemical components of a wetland, such as soils, water, plants and animals, enable the wetland to perform many vital functions, for example: water storage, storm protection and flood mitigation; shoreline stabilization and erosion control; ground water recharge; ground water discharge; water purification through retention of nutrients, sediments, and pollutants; and stabilization of local climate conditions, particularly rainfall and temperature. Environmental condition such as pH, salinity, temperature and nutrients influence the composition, distribution and growth of its biota (Sridhar *et al.,* 2008). Water quality can be assessed by numerous variables (Mausbach and Seybold, 1998). In addition to physico-chemical variables, biotic variables also reflect quality (Pankhurst *et al.,* 1997). Physico-chemical variables often show different patterns of response to the same impact (Jha *et al.,* 1992), reflecting the multidimensional quality of water health (van Straalen, 2002).

In addition to physico-chemical profiling of soil and water, various methods of multivariate profiling of soil and water based on microbial observations have been proposed (Kirk *et al.,* 2004). Changes in quality can be detected by observing community level physiological profiles of soil bacterial communities (Garland and Mills, 1991). Analysis of the physiological activity of bacteria may reveal important information about soil quality which may go undetected by physico-chemical analysis, because bacterial activity responds differently to impact than do physico-chemical parameters (Doi and Puriyakorn, 2007).

Materials and Methods

Study Area

KNP (Fig.1), Bharatpur, Rajasthan, declared as a protected area and bird sanctuary in 1956 and in 1981 upgraded to a National Park, (Sharma and Praveen 2002). The 29 Km^2 park (27^0 7.6' – 27^0 12.2' N and 77^0 29.5'- 77^0 33.5' E, almost equidistant, about 180 km , between

Delhi and Jaipur) is one of the important waterfowl habitats in the country (Azeez et al., 2007), and one of the early Ramsar sites (Mathur et al., 2005). The park is segmented into 15 blocks, named alphabetically from A to O, separated by earthen dykes or mud trails, for ease of management and tourism. Of the 15 blocks in the park, 6 blocks were selected for the periodic collection of water samples. These sites represent the entire habitat of the park. The sites selected for the periodic collection of water samples are named as follows: A block, B block, D block, E block, K block and L block.

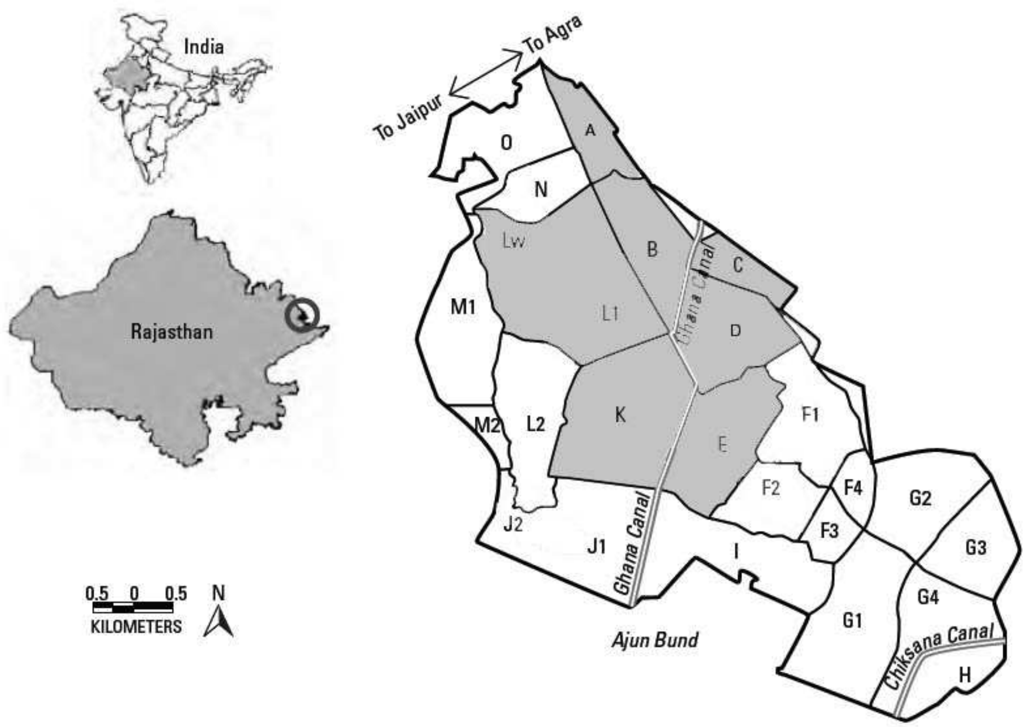


Figure 1: Different blocks (A, B, D, E, K and L) of Keoladeo National Park

Collection of Samples

The water samples were collected in sterilized sampling bottles of 250ml capacity marked with stickers. These samples were brought to the laboratory under cold conditions and stored at 4^0C till further use.

Water pH

The pH of water samples was recorded immediately at the time of collecting the water samples in the park by using pocket size pH meter after calibrating it with standard buffer of pH 4 and pH 10 (McClean, 1982).

Physicochemical Studies of Wetland Water

Organic carbon in water samples was analyzed following the method of Datta et al., (1962), Inorganic phosphorous was analyzed following method of Fiske and Subbarow (1925). Sodium, and potassium was analyzed by using flame photometer (Doll and Lucas, 1973), Calcium was estimated by EDTA method (Trivedi and Goel 1986), total nitrogen content was estimated by Kjeldhal digestion method (Fleck 1967) in water samples.

Statistical analysis

Statistical analysis was done with the help of Graph pad prism Software. All the results were shown as Mean ± SEM. Values were statistically significant at $P < 0.05$ and $P < 0.0001$.

Results and Discussion

Studies of physico-chemical characteristics of water of KNP suggests that the various parameters depending upon the hydrochemistry of the study area and also the trees and forest soil purify water as it flows through forest ecosystems. Different aspects of water have been studied such as physicochemical characteristics of water.

pH of Water

The hydrogen ion concentration of water is a measure of its acidity. A pH of 8.5 or higher is a good indication that the water is high in soluble salts. Using water with high pH may require special cropping and irrigation practices (Glover, 1996). The pH values of water samples are shown in figure 2 for the acidity. The pH values of water samples are between 6.6 and 8.4. In first season pH recorded from 6.6±0.186 to 8.4±0.208. In this season the minimum pH recorded in A-block and maximum pH in D-block. In second season pH ranged from 7.0±0.100 to 8.0±0.208. The minimum pH recorded in A-block and maximum pH recorded in K-block. In third season it ranged from 7.1±0.153 to 7.3±0.058. In this season the minimum recorded in A and K-block and maximum pH in D-block. Statistically, Comparing pH of all blocks of all the seasons, it showed the non-significant difference at $P<0.05$, but when compared with season 1 to season 3 D & K Block were significant at $P<0.001$ and season 2 to season 3 of K-Block was found to be significant at $P<0.01$.

Water samples having pH values greater than 8.0 would be expected to contain high carbonates and bicarbonates, which may form precipitate with calcium and may block the equipment. The usefulness of the water would depend on the relative amounts of these salts (DPI, 2010). pH was alkaline through study period at all blocks, which is a characteristic feature of the aquatic environment (Rajasegar, 2003).

Inorganic Phosphate Concentration

It is evident from the data of figure 3, that the concentration of inorganic phosphate ranged from 0.090±0.001 µg/ml to 2.021±0.002 µg/ml in the water samples collected from different sampling sites (blocks) during August 2006 (Season1). The concentration of inorganic phosphate ranged from 0.095±0.001 µg/ml to 2.051±0.001 µg/ml in the soil samples collected from different sampling sites (blocks) during April 2007 (Season2). However, the concentration of inorganic phosphate ranged from 0.105±0.002 µg/ml to 2.060±0.001 µg/ml during Nov.2007 (Season3). During first, second and third sampling, the highest (2.021±0.002 µg/ml, 2.051±0.001 µg/ml and 2.060±0.001 µg/ml respectively) and lowest (0.090±0.001 µg/ml, 0.095± 0.001µg/ml and 0.105±0.002 µg/ml respectively) concentration of inorganic phosphate was recorded in K-Block and D-Block, respectively. The concentration of inorganic phosphate increases in season 2 and season 3 sampling than season1 sampling. Statistically, comparing inorganic phosphate of all blocks with season 1 to season 2 it showed the non-significant difference at $P<0.05$ only K Block was found to be significant. But when compared with season 1 to season 3 of all blocks were found to be significant at $P<0.001$, only of A Block was found to be significant at $P<0.01$. While with season 2 to season 3 of A & L Block were non-significant, E-Block was found to be significant at P<0.001, D & K were found to be significant at P<0.01 and only B-Block was found to be significant difference at p<0.05. Phosphorous is the naturally occurring element that occur in the mineral, soil, living organism and water. Phosphorus stored in the uppermost layers of the bottom sediments of lakes and reservoirs is subject to bioturbation by benthic invertebrates and chemical transformations by water chemistry changes (Gopal and Zutshi, 1998).

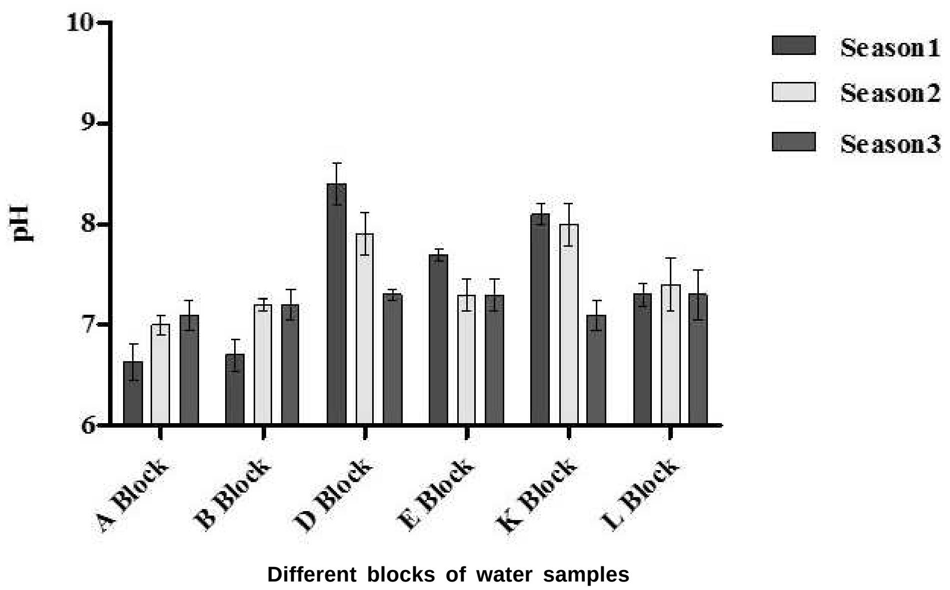


Figure 2: Seasonal variation of water pH recorded at block A-L

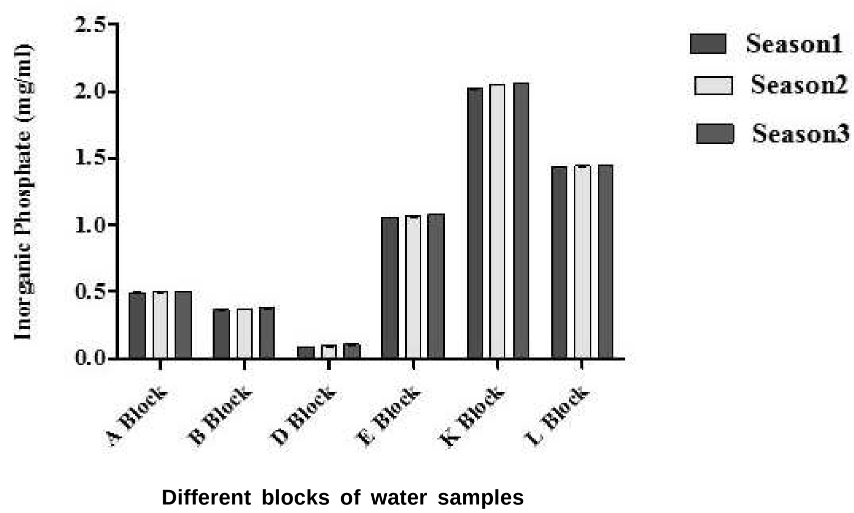


Figure 3: Seasonal variations of Inorganic Phosphate of water recorded at block A-L.

Organic Carbon Concentration

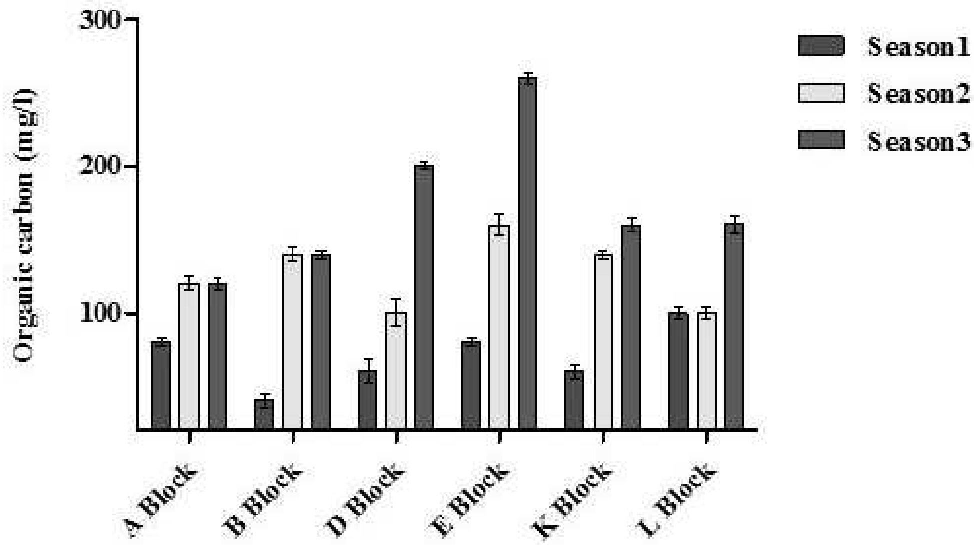
It is evident from the data of figure 4, that the concentration of organic carbon ranged from 40±4.509 mg/l to 100± 4.583 mg/l in the water samples collected from different sampling sites (blocks) during August 2006 (Season1). However, the concentration of organic carbon ranged from 100±9.539 mg/l to 160±4.726 mg/l during April 2007(Season2). While, during Nov. 2007(Season3) the concentration of organic carbon ranged found from 120±4.359 mg/l to 260±4.509 mg/l. The data of figure indicate that highest concentration of organic carbon in L-block and the lowest concentration of organic carbon in B-block were recorded in season1 and in season 2 the highest concentration in E-block and the lowest concentration in L & D-block occurred. While in season 3 the highest concentration in E-block and the lowest concentration in A-block were recorded. The concentration of organic carbon increase in season 2 and season3 sampling than season1 sampling. Statistically, comparing organic carbon of all blocks of all the seasons, it showed the significant difference at $P<0.001$, but when compared with season 1 to season 2 of L-Block and season 2 to season 3 of A, B and K-Block were found to be non-significant at $P<0.05$.

Dissolved organic carbon (DOC) in marine and freshwater ecosystems is one of the Earth's largest actively cycled reservoirs of organic matter (Bushaw *et al.,* 1996) and it is the most abundant dissolved substance entering oligotrophic boreal lakes (Schindler and Bayley, 1993).

Total Nitrogen Concentration

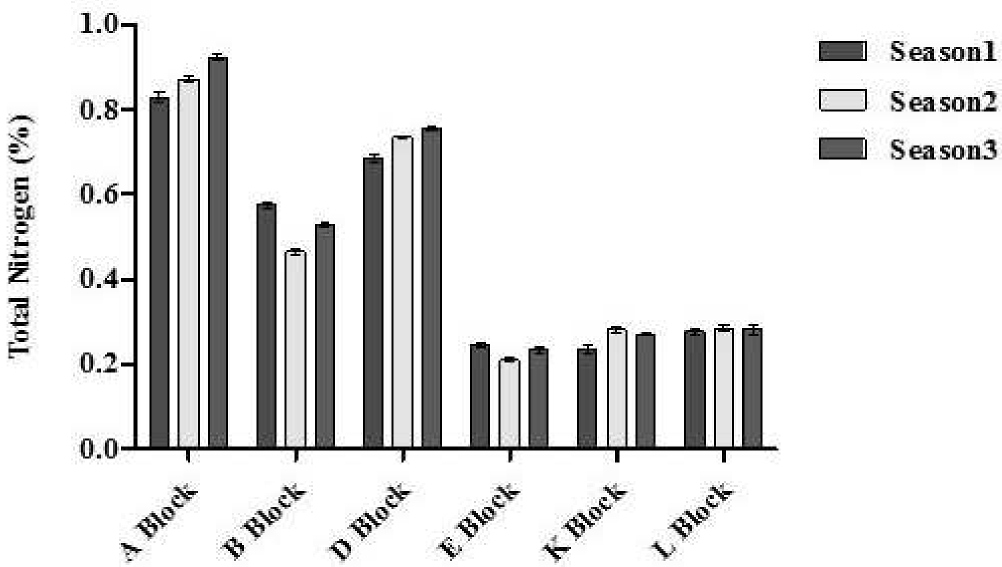
It is evident from the data of figure 5, that sodium concentration ranged from 0.235±0.008 % to 0.829±0.011 % in the water samples collected from different sampling sites (blocks) during August 2006 (Season1). However, the concentration of sodium ranged from 0.210±0.004 % to 0.870±0.007 % in the water samples collected from different sampling sites (blocks) during April 2007 (Season2). While, the concentration of sodium ranged from 0.233±0.009 % to 0.923± 0.007 % in the water samples collected from different sampling sites during Nov.2007 (Season3). During first sampling, the highest (0.829±0.011%) and lowest (0.235±0.008 %) concentration of sodium was recorded in A-Block and K- Block, respectively. In contrast, during second and third sampling, the highest (0.870 ±0.007 % & 0.923±0.007 %) and lowest (0.210±0.004 % & 0.233±0.009 %) concentration of sodium was recorded in A-Block and E-Block, respectively. Statistically, comparing total nitrogen of all blocks with season 1 to season 2 it showed the significant difference at $P<0.001$, but of E-Block was found to be significant at $P<0.01$ and only of L-Block was non-significant. When compared with season 1 to season 3 of K-Block was found to be significant at $P<0.01$ and of E & L Block were non-significant. While compared season 2 to season 3 only of A-Block and B-block were found to be significant at $P<0.001$.

High nitrogen concentration is a marker of algal blooms in the area. In rivers and lakes the inorganic components of total nitrogen (ammonia, nitrate and nitrite) will become available for algal growth. High total nitrogen levels together with high phosphorus levels and in conjunction with favorable physical characteristics of aquatic environments this may result in algal blooms (Radin and Ackerson, 1981). After assimilation in algal (plant) growth, microbial breakdown and other processes such as mineralization and nitrification may transform organic nitrogen through various steps into inorganic forms of nitrogen such as ammonia, nitrite and nitrate. Such type where the concentration of total nitrogen is higher will be good in case of agriculture point of view.



Different blocks of water samples

Figure 4: Seasonal variations of Organic Carnon of water recorded at block A-L.



Different blocks of water samples

Figure 5: Seasonal variations of Total Nitrogen of water recorded at block A-L.

Sodium Concentration

It is evident from the data of figure 6, that sodium concentration ranged from 11.8± 0.493 ppm/L to 51.3±1.026 ppm/L in the water samples collected from different sampling sites (blocks) during August 2006 (Season 1). However, the concentration of sodium ranged from 29.3±0.208 ppm/L to 46.1±0.557 ppm/L in the water samples collected from different sampling sites (blocks) during April 2007 (Season2). While, the concentration of sodium ranged from 30.1±0.384 ppm/l to 48.2±0.306 ppm/L in the water samples collected from different sampling sites during Nov. 2007 (Season3). During first sampling, the highest (51.3±1.026 ppm/L) and lowest (11.8±0.493 ppm/L) concentration of sodium was recorded in D-Block and B Block, respectively. In contrast, during second and third sampling, the highest (46.1± 0.557 ppm/L & 48.2±0.306 ppm/L) and lowest (29.3±0.208 ppm/L & 30.1±0.384 ppm/L) concentration of sodium was recorded in L-Block and K-Block, respectively. Statistically, comparing sodium of all blocks with season 1 to season 2 it showed the significant difference at $P<0.001$, only of A-Block was non-significant. When compared with season 1 to season 3 of all blocks were found to be significant at $P<0.001$, D-Block was found to be significant at $P<0.01$ and of A Block was non-significant. While compared season 2 to season 3 of all blocks were found to be non-significant difference at $p<0.05$, only of D-Block was found to be significant at $P<0.001$.

Plants need salt to complete necessary chemical processes. However, too much salt can have a negative impact on the plant's appearance, hydration and growth. Unlike freshwater, which can easily be absorbed through the roots without problems, saltwater tends to be more difficult (Yaron and Thomas, 1968).

Potassium Concentration

It is evident from the data of figure 7, that potassium concentration ranged from 10.3±0.513 ppm/L to 23.6±1.185 ppm/L in the water samples collected from different sampling sites (blocks) during August 2006 (Season1). However, the concentration of potassium ranged from 11.8±0.529 ppm/L to 21.2±1.637 ppm/L in the water samples collected from different sampling sites (blocks) during April 2007 (Season2). However, the concentration of potassium ranged from 14.3±1.250 ppm/L to 21.2±1.637 ppm/L during Nov.2007 (Season3).During first sampling, the highest (23.6±1.185 ppm/L) and lowest (10.3±0.513 ppm/L) concentration of potassium was recorded in A-Block and K Block, respectively. In contrast, during second sampling, the highest (21.2±1.637 ppm/L) and lowest (11.8±0.529 ppm/L) concentration of potassium was recorded in K-Block and D-Block, respectively. However, during third sampling, the highest (21.2±1.637 ppm/L) and lowest (14.3±1.250 ppm/L) concentration of potassium was recorded in A-Block and D-Block respectively. Concentration of potassium was increasing in the water collected from all the blocks from previous sampling. Statistically, comparing potassium of all blocks with season 1 to season 2 it showed that of B & K Block were found to be significant difference at $P<0.001$, but of E-Block and A Block were found to be significant at $P<0.01$ & $P<0.05$ respectively. Only of D-Block showed non-significant. when compared with season 1 to season 3 of all blocks were showed non-significant difference only of B & L Block were found to be significant at $P<0.05$. While compared season 2 to season 3 of all blocks were found to be non-significant difference at $P<0.05$ only K-block was found to be significant at $P<0.05$.

Potassium influences the water economy and crop growth through its effects on water uptake, root growth, maintenance of turgor, transpiration and stomatal regulation (Nelson, 1980). It has an important role either direct or indirect, under different environments, in major plant processes such as photosynthesis, respiration, protein synthesis and enzyme activation, water uptake, osmo-regulation, growth and yield of plant (Li et al., 1989; Zaidi et al., 1994).

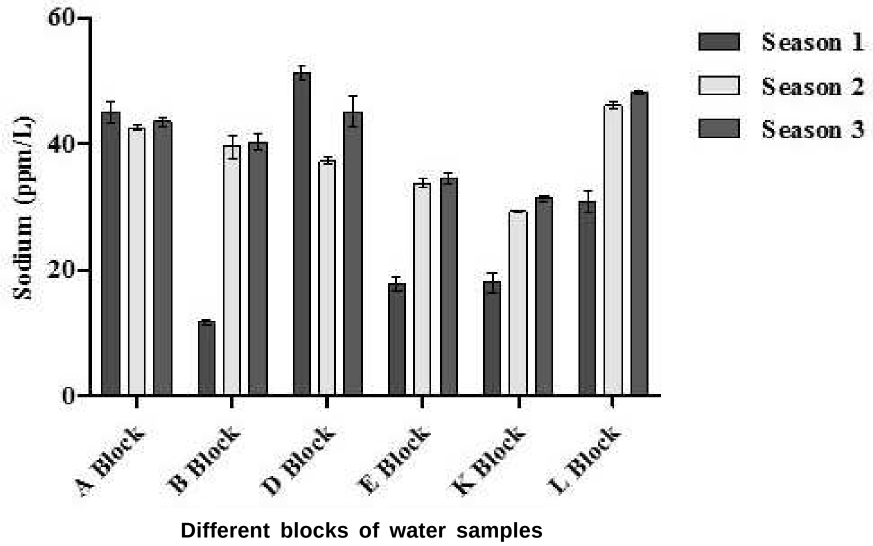


Figure 6: Seasonal variations of Sodium of water recorded at block A-L.

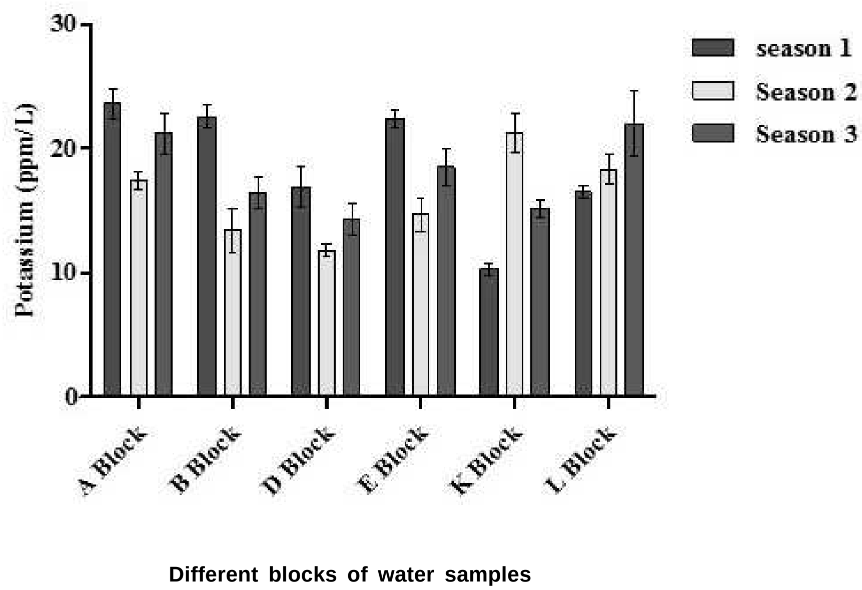
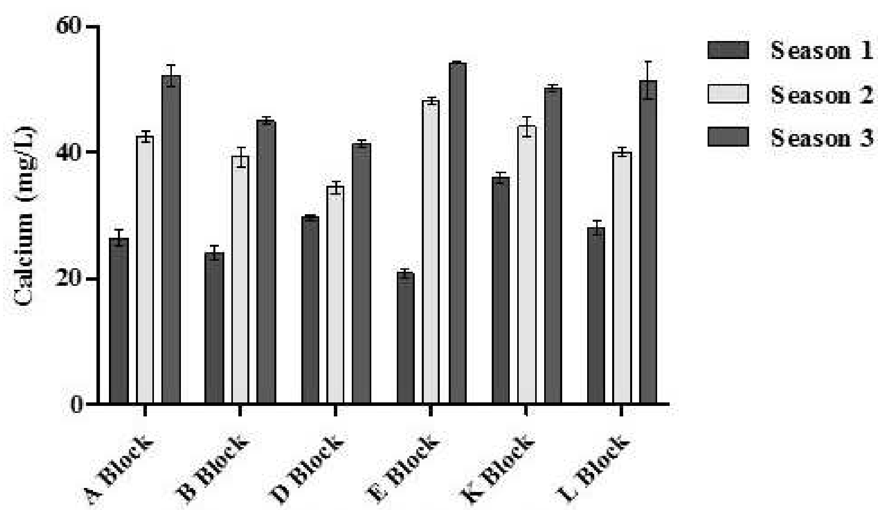


Figure 7: Seasonal variations of Potassium of water recorded at block A-L.

Calcium Concentration

It is evident from the data of figure 8, that the concentration of calcium ranged from 20.84 ±0.612 mg/l to 36.07±0.822 mg/l in the water samples collected from different sampling sites (blocks) during August 2006 (Season1). The concentration of calcium ranged from 34.47±1.005 mg/l to 48.09±0.563 mg/l in the soil samples collected from different sampling sites (blocks) during April 2007 (Season2). However, the concentration of calcium ranged from 41.34±0.650 mg/l to 54.23±0.151 mg/l during Nov.2007 (Season3). It is evident from the data of Fig.4.14 that the highest (36.07± 0.822mg/l) and the lowest (20.84±0.612 mg/l) concentration of calcium was recorded in K-block and E-block, in season1. However, in season 2 and third sampling the highest and the lowest concentration of calcium was recorded in E-block and D-block .However, the concentration of calcium was increasing in the water collected from all the blocks from previous sampling. Statistically, comparing calcium of all blocks of all the seasons, it showed the significant difference at $P<0.001$, but when compared with season 1 to season 2 of D-Block was found to be significant at $P<0.05$and season 2 to season 3 of B, D, E and K-Block were found to be significant at $P<0.01$.

Calcium is an important determinant of water harness (Man and Cai, 2005). It occurs in water naturally. Seawater contains approximately 400 ppm calcium. One of the main reasons for the abundance of calcium in water is its natural occurrence in the earth's crust. Calcium is also a constituent of coral. It may dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. Calcium is dietary requirement for all organisms apart from some insects and bacteria. Therefore, Block E will be the best place for the growth of plants animals and microbes (Schot and Wassen, 1993).



Different blocks of water samples

Figure 8: Seasonal variations of Calcium of water recorded at block A-L.

Conclusion

Wetland ecosystem absorbs and recycles essential nutrients, treat sewage and cleanse waste. Trees and forest soil purify water as it flows through forest ecosystems. Some 130 billions metric tons of organic waste is processed every year by earth's decomposing organisms. Many industrial wastes including detergents, oils, acids, and paper are also detoxified and decomposed by the activities of living things. The physicochemical study of the wetland in KNP during this study revealed their physicochemical characteristics of water as being suitable for microbial growth. Wetland under study revealed high organic matter content. Organic carbon is the main energy source for bacteria, so it increased the level of bacterial population in wetland. High nitrogen level shows that the soil contains high fraction of sand which prevent losses by leaching in the soil during the growing rainy season. Statistically, the physicochemical properties also revealed that there were no correlation in the interaction which involved pH of water and seasons. It is thus expressed that the pH of water do not necessarily dependent on the seasons. Statistically also showed significant difference between seasons and total nitrogen, potassium, water sodium and calcium at $P<0.001$. This shows that these parameters are dependent on seasons.

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