THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Maheepal Singh et al, The *Experiment, 2014, Vol.25(3)1726-1735*

CORRELATIVE STUDY OF PHYSICO-CHEMICAL AND MICROBIOLOGICAL PARAMETERS OF RADHA AND SHYAM KUND GOVARDHAN, MATHURA (U.P)

ABSTRACT

In the present study physico-chemical and microbiological characteristics of the water of Radha Kund and Shyam Kund were analyzed and compared from March 2011 to February 2012. Physical parameters like temperature, turbidity, total dissolved solids (TDS), chemical parameters like alkalinity, hardness, pH, sulphate, chloride, fluoride, nitrate, phosphate, dissolved oxygen (DO), chemical oxygen demand (COD) and biological oxygen demand (BOD) were studied. Also microbiological parameters such as total coliforms, pathogen presence and total viable count were analyzed. Physicochemical parameters like turbidity, hardness, sulphate, DO and BOD is exceeding the limits prescribed by Bureau of Indian Standards (BIS, 2012). Correlation of physicochemical with total coliform count reveals that there is a strong positive association with temperature, turbidity, pH and alkalinity. Chloride, fluoride and DO are negatively correlated with total coliform count.

Keywords Physicochemical, microbiological parameters, analysis of water, Radha kund, Shyam kund, Pearson correlation

INTRODUCTION

Water is the most fundamental element making life possible on this planet and has a unique position in the renewable sources (Kumar et al., 2005). Water is generating a lot of concern due to its exhaustible nature (Shyamala et al.2008). Prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and created health problem (Raja et al, 2002). In recent times it poses a threat to the various sectors of the society due to its overexploitation. The quality of water is also deteriorating due to pollution.

Now-a-days, the ecology of reservoirs is under stressed condition due to the fast pace of development, deforestation, cultural practices and agriculture. These activities trigger the rate of sedimentation of the reservoir bed which initiates the process of eutrophication at a very early stage (Agarwal and Rajwar, 2010).

Lakes and ponds are dynamic ecosystems and one of the primary resources for water. They act as indicators of variations in climate and biological components. Water quality issues are based on the biological productivity of the lake, water chemistry profile, nutrient concentrations, specific pollutants and historic trends (Saha and Ghugare, 2008).

Water for different purposes has its own requirements for the composition and purity and each body of water has to be analysed on a regular basis to confirm the suitability. Diarrhoea, cholera, dysentery, and various other diseases like Typhoid, Amoebiasis, Jaundice, Enterobacteriaceae, etc. are caused on consumption of contaminated water (Mishra, 2010). Many infectious diseases are transmitted by water through the fecal-oral route. Diseases contacted through drinking water kill about 5 million children annually and make 1/6th of the world population sick (WHO, 2003).

Thus it becomes very essential to analyze the physical, chemical and microbiological parameters of the water bodies which are frequently in use by the humans and animals. The study involves the primary analysis of physicochemical and microbiological parameters of the Radha and Shyam kund and its comparison with the WHO standards to determine the water quality.

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

MATERIAL AND METHODS

Background Of Study Area

The town Govardhan is famous for its 21 kilometre long Parikrama of the very old hill called Govardhan. Along the religious Govardhan Parvat Parikrama, there are a numerous kunds or water tanks which are associated with myths and legends of the lifetime of Krishna and Radha. Radha kund and Shyam kund are considered the most sacred kunds amongst the 23 kunds along the parikrama route and thus are highly visited kunds.

The Radha Kund is forever linked with the Shyam Kund that is situated right beside it. The lake area has many structures, including temples, shrines and memorials. The kunds are used for bathing, washing, worshipping and watering livestock. The kunds get their water supply through rainfall and ground water. As these kunds have mythological importance, a lot of pilgrims and tourists come and stay throughout the year. Religious rituals of pilgrims and visiting of tourists worsen the condition of kunds and their surroundings. Lack of sewerage and drainage system in the surrounding community put the kunds at risk.

Sampling

Water samples were collected in HDPE (High density polyethylene) screw capped bottles and stored at 4°C till further analysis. Samples for microbiological analysis were collected in sterile bottles, stored at 4°C and utilized within 4 hours of collection. Samples were collected during the premonsoon (February to May), postmonsoon (October to January) and monsoon (June to September) seasons. Samples were collected from six spots from Radha and Shyam kund.

Following characteristics were analyzed in the study:

Physical Characteristics

The physical characteristics included temperature (Direct thermometer), turbidity (Nephelometric method), total dissolved solids (TDS) (Evaporation method).

Chemical Characteristics

The chemical characteristics included pH (Direct pH meter), alkalinity (Titration method), hardness (EDTA method), dissolved oxygen (DO) (Winkler's method), chemical oxygen demand (COD) (Closed reflex method), biological oxygen demand (BOD) (Indometric azide method), chloride (Argentometric method), nitrate (Brucine method) phosphate (Colorimetric Method), sulphate (Turbidimetric Method) and fluoride (SPANDS method)

Microbiological characteristics

The microbiological parameters studied were pathogen detection, total coliform count and total viable count.

All the physico-chemical parameters were analyzed by the methods given by Trivedy and Goyal (1992) and APHA (2005). Microbiological analyses of water samples were performed as described in Standard Methods for the Examination of Water and Wastewater (APHA - AWWA, 2005).All chemicals and dehydrated culture microbiological media used in testing belong to Merck Ltd.

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Statistical analysis

Pearson correlation coefficient was computed to determine the inter relation between the physicochemical and microbiological parameters. Pearson correlation coefficient (r) is a measure of the linear correlation (dependence) between two variables X and Y, giving a value between +1 and −1 inclusive, where 1 is total positive correlation, 0 is no correlation, and −1 is total negative correlation. The calculation was done using the online calculator (Social science statistics).

RESULTS AND DISCUSSION

The comparative analysis of the physicochemical parameters of Radha and Shyam kund is graphically represented in figure 1.

Temperature impacts the physical and biological characteristic of water. A rise in temperature of water leads to the speeding up of the chemical reactions in the water. Average monsoon temperatures of the kunds was 36°C, during premonsoon it was 32°C and post monsoon it was 16°C. High summer temperature and bright sunshine accelerate the process of decay of organic matter resulting into the liberation of large quantities of CO_2 and nutrients (Agrawal and Rajwar, 2010 and Sharma et al, 2008).

Turbidity is one of the most important parameters to decide the suitability of water for various purposes. Higher turbidity hinders the chlorination/disinfection process (Asano, 2007). Bacteria utilize these suspended solids as sites of attachment there by increasing the microbial load (Hurst, 1996 and Kurup R et al, 2010).The average value for turbidity was 69.5 NTU in monsoons, 23 NTU during postmonsoon and 31.50 NTU in premonsoon. Surface runoffs and domestic and religious wastes that flow down to these kunds results in increase in the turbidity of the kunds (Agrawal and Rajwar, 2010).

In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles (Mahananda et al, 2010).The high amount of TDS in turn affects the quality of running water. Higher amount of total dissolved solids leads to increased turbidity (Kumar and Bahadur, 2009). The average value in monsoon was 902.6 mg/L, in premonsoon it was 743.9 mg/L and postmonsoon it was 679.5 mg/L

The average value of pH was 6.7 during the post monsoon, 7.2 during pre monsoon and 7.7 in monsoon season. pH values were slightly on a higher side in Radha kund. The high pH value could be due to high temperatures observed in this month which reduces the CO_2 solubility in turn increasing pH (Mahananda et al, 2010). The pH values depend on the rate of photosynthesis of algal blooms which cause precipitation of carbonates and bicarbonates. During monsoon rate of photosynthesis is high, thus there is increased precipitation leading to high pH. During winter it is low thus pH values are low (Agrawal and Rajwar, 2010). Another reason for high pH values could be due to waste discharge from domestic waste and waste generated due to religious activities.

Water hardness values in monsoon is 1327 mg/L, during post monsoon is 1279 mg/L and pre monsoon is 1395 mg/L. The water hardness on all study sampling points of both the kunds was higher during the months of February to May which might have caused increased concentration of salts by excessive evaporation as observed by Bhatt et al. (1999).

Alkalinity plays an important role in controlling enzyme activities. Maximum value of alkalinity seen during monsoon was 346 mg/L and minimum in post monsoon which is 249.18 mg/L. In the present investigation the alkalinity level reduced in the post-rainy months.

DO is a very important parameter of water quality and an index of physical and biological process going on in water. DO values are extremely crucial in determining the nature of the microbial flora and also the purity of water (Agrawal and Rajwar, 2010).

The highest concentration 8.27 mg/L was recorded during post monsoon and lowest concentration was 6.01 mg/L in pre monsoon.

BOD measures the amount of oxygen used by microorganisms to oxidize organic matter present within the water sample (Nielsen 2003).The values of BOD clearly showed higher concentration during most of the summer and rainy months and comparatively low during winter months (Agrawal and Rajwar, 2010). This clearly indicates that BOD is inversely proportional to DO values (Devraju et al, 2005) BOD value in monsoon was 17.48 mg/L, in post monsoon was 11.42 mg/L and pre monsoon was 16.17 mg/L.

Chemical Oxygen Demand (COD) is used to measure oxygen used and equate it to the amount of organic matter within the water sample (Kurup R et al, 2010). It gives a direct account of the pollutants present in the water body by effluents and domestic waste (Kumar and Bahadur, 2009). The average COD values range from 56.64 mg/L during the pre monsoon months, 47.55 mg/l during monsoon and 34.08 mg/l during the post monsoon months.

Chloride is one of the important indicators of faecal pollution present in sewage, effluents and farm drainage. (Agrawal and Rajwar, 2010). The salts of sodium, potassium and calcium contribute chlorides in waters. The average chloride values ranged from 710.06 mg/L, 655.36 mg/L and 673.05 mg/L in the pre monsoon season, monsoon and post monsoon respectively. Chloride values are on the higher side in Radha kund as compared to Shyam kund. The lower values during the rainy season could be due to the dilution of the kund water during the season (Kumar and Bahadur, 2009).

Phosphate is present in relatively low quantities in the kunds as the aquatic plants absorb phosphate more than their requirement and store it within. (Mahananda et al ,2010). Average phosphate value in monsoon 0.85 mg/L, in post monsoon was 0.87 mg/L and pre monsoon was 0.75 mg/L.

Sulphate occurs naturally in all the water bodies. Since the kunds at Govardhan are located in the semiarid region, they have higher concentration of the anion due to the accumulation of soluble salts in the soils. Average concentration observed is 560.31 mg/L during pre monsoon, 654.79 mg/L in monsoon and 549.42 mg/L in post monsoon.

Nitrate concentration depends on the activity of nitrifying bacteria which in turn get influenced by presence of dissolved oxygen. The average value observed in pre monsoon was 0.70 mg/L, in monsoon it was 0.66 mg/L and in post monsoon it was 0.50 mg/L. Decrease in nitrate content during winter months was probably due to its utilization by the algal community as nutrient (Agrawal and Rajwar, 2010). Monitoring of nitrates in drinking water supply is very important because of health effects on humans and animals (Mahananda et al, 2010).

Fluoride at a lower concentration at an average of 1 mg/lit is regarded as an important constituent of drinking water. Surface water generally contains less than 0.5 mg/lit fluoride. Average fluoride value in monsoon was 0.74 mg/L while in post monsoon and pre monsoon it was 0.76 mg/L. It is just near to the acceptable limits.

On comparison with the BIS standards it is observed that turbidity, hardness, sulphate, DO and BOD are exceeding the prescribed limits.

Microbiological Parameters

Microorganisms are widely distributed in nature, and their abundance and diversity may be used as an indicator for the suitability of water (Okpokwasili & Akujobi, 1996). Microbial analysis thus helps in determining the microbial count and the presence of disease causing microbes. The microbiological parameters studied were Pathogen detection; Total coliform count and total viable count.

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Pathogen Testing

In order to check the presence of harmful bacteria the water is tested for four pathogens which are known as indicator bacteria. The presence and absence of these helps in determining the level of risk related to these pathogens.

When tested for pathogens Escherichia coli were seen to be present during monsoon and pre monsoon seasons of both the kunds. Salmonella typhi is present during pre monsoon in Shyam kund while it is absent in Radha kund. Pseudomonas aeruginosa is absent in both the kunds in all the seasons. Staphylococcus aureus is present in both the kunds during pre monsoon and monsoon period. Pathogen presence is predominant during the monsoon and post monsoon period. Table 2 shows the presence of pathogens in Radha and Shyam kund.

Total viable count (TVC)

It is the technique to enumerate the heterotropic bacteria. For both the kunds the average count of pre monsoon months was $63X10^5$/ml, of monsoon was $97X10^5$/ml and post monsoon was $42X10^5$/ml. Shyam kund shows higher counts in all the season as compared to Radha kund. The count exceeds largely from the permissible limit. Table 3 denotes the TCC and TVC of Radha and Shyam kund for all the seasons

Total coliform count (TCC)

The most basic test for bacterial contamination of a water body is the test for total coliform bacteria**.** Total coliform counts give a general indication of the sanitary condition of the water body. Average count of both the kunds during pre monsoon is $39X10^3$/ml, in monsoon it was $76X10^3$/ml and in post monsoon it was $32X10^3$/ml. The TCC is very high and does not fall within the BIS limits which are zero.

The maximum number of bacterial population was observed in the monsoon months which were due the influx of organic matter from the surrounding areas which increases the turbidity. The rain brings in particulate matter which is absorption sites for these bacteria (Agrawal and Rajwar 2010). The high values of total Coliforms are an indicator of increasing pollution of the kund through the discharge of domestic effluents into the kund (Kumar and Bahadur 2009).

Statistical analysis

Correlation of total coliform count and the other parameters was determined for Radha and Shyam kund. Table 4 shows the r value for Radha and Shyam kunds.

Temperature, pH, turbidity, alkalinity are the parameters that have very strong positive correlation with total coliform count for both Radha and Shyam kund. This indicates that an increase in the value of these parameters will lead to an increase in the total coliform count and vice versa. Fluoride and chloride show weak negative correlation with total coliform count for both the kunds. DO shows weakly negative for Radha and moderately positive for Shyam kund. Negative correlation implies that increase in one parameter leads to decrease in the other and vice versa.

From correlation studies we observed that change in temperature; pH, turbidity and alkalinity have a great impact on the total coliform count. Phosphate, hardness, chloride and fluoride have a weak association implying that a change in these parameters does not have any impact on the TCC.

CONCLUSION

The analysis and comparison of physicochemical parameters during the three seasons denotes that the parameters like turbidity, hardness, suplhate, DO and BOD exceed the BIS limits.

Microbial count of the kunds is way above the prescribed limits. Pathogen detection studies show that the four pathogens are predominant during the pre monsoon and the monsoon period. The kunds are highly contaminated. The water is unsuitable for consumption and recreational purposes without treatment.

Correlation studies reveal that temperature, pH, alkalinity and turbidity have a strong positive association with total coliform count while DO is negatively associated with TCC.

Total coliform count is highly influenced by change in temperature, pH, turbidity and alkalinity whereas chloride, fluoride and phosphate do not influence the TCC.

This primary study reveals that the water quality of Radha and Shyam kund is similar in terms of physicochemical and microbiological parameters.

This study holds great scope for further detailed research which could involve the decontamination of the kunds to reduce the microbial load and the restoration of the kunds. This will maintain the religious sanctity of the kunds

ACKNOWLEDGEMENTS

Professor S.K Singh for guiding me throughout the study

REFERENCES

1. APHA (2005). Standard methods for examination of water and waste water 21 ed. American Public Health Association Washington DC. USA.
2. Agrawal A, Rajwar G. Physicochemical and Microbiological Study of Tehri dam Reservoir, Garhwal, India. Journal of American Science; 2010:65-71.
3. Asano T. Water reuse: Issues, technologies, and applications. New York: McGraw-Hill; 2007.
4. Bhatt L. R, Lacoul P, Lekhak H. D, Jha P. K. Physico-chemical characteristics and phytoplanktons of Taudaha lake, Kathmandu. Poll. Res.1999;18(4):353-358..
5. BIS 2012, Indian Standard: Drinking water- Specification, 2nd revision. IS10500:2012; 1-18
6. Devarju , T., Venkatesha M, Singh P. Physico-chemcial parameter of Maddur lake with reference to suitability for aquaculture. Nature Env. And Poll. Tech. 2005;4(2):287-290 .
7. Hurst C. J, Clark R. M, Regli S. E. Estimating the risk of acquiring infectious disease from ingestion of water. Chapter 4. pp.. In C. J. Hurst (ed.), Modeling Disease Transmission and Its Prevention by Disinfection. Cambridge University Press, Cambridge;1996:99-139
8. Kumar A, Bahadur Y. Physico-chemical Studies on the Pollution Potential of River Kosi at Rampur (India). World Journal of Agricultural Sciences;2009:5(1):1-4.
9. Kumar, R., Singh R. D. and Sharma K.D.Water resources of India, Current. Science.2005; 89:794 – 811.
10. Kurup R, Persaud R, Caesar J, Raja V. Microbiological and physiochemical analysis of drinking water in Georgetown, Guyana.

Nature and Science; 2010;261-265.

11. Okpokwasili, G. C. & Akujobi, T. C. (1996): Bacteriological indicators of tropical water quality. Environ. Tox.. Water Qual.;1996;11:77–81.
12. Mahananda M R, Mohanty B.P, Behera N R. Physico-chemical analysis of surface ad Ground Water Of Bargarh District, Orissa, India. IJRAS; 2010;2(3):284-295.
13. Mishra, A. 2010. Assessment of Water Quality Using Principal Component Analysis: A Case Study of the River Ganges. Sov J. Water Chem. Technol.;2010; 32 (4): 227 - 234.
14. Nielsen, P. H., Thomsen, T. R., and Nielsen, J. L. Bacterial Composition of Activated Sludge – Importance for Floc and Sludge Properties. Water Science and Technology; 2004;49(10): 51-58.
15. Pearson correlation calculator. Social sciences Statistics. http://www.socscistatistics.com/tests/pearson/Default2.aspx
16. Raja R.E., Lydia Sharmila, Princy Merlin, Chritopher G ,Physico-Chemical Analysis of Some Groundwater Samples of Kotputli Town Jaipur, Rajasthan, Indian J Environ Prot.;2002;22(2):137.
17. Saha A, Kansal M L Mishra G C and Gupta R P. Restoration of the Traditional Small Water Bodies in Braj. South Asian Journal of Tourism and Heritage; 2010;3(2):19-29.
18. Shaha, S.S and S. Ghugare 2008. Conservation and Management of Lake - Case Studies. Proceedings of Taal 2007: The 12 World Lake Conference: 1488-1494.
19. Sharma R, Sharma M, Sharma V, Malara H. Study of Limnology and Microbilogy of Udaipur Lakes. Proceedings of Taal, The 12th World Lake Conference;2007:1504-1508.
20. Shyamala, R., Shanthi, M. and Lalitha, P. Physicochemical analysis of borewell water samples of Telungupalayam area in Coimbatore District, Tamilnadu, India. E-Journal of chemistry.2008;5(4):924-929.
21. Trivedy, R.K. and Goyal P.K.Chemical and biological methods for water pollution studies. Environmental, Publication, Karad;1992.
22. WHO. 2003. Background document for preparation of WHO Guidelines for drinking water quality. Geneva, World Health Organization. WHO /SDE /WSH/ 03.0

Parameter	Radha kund	Shyam kund	Permissable limits
Temperature (°C)	27.76	27.71	40±5
Turbidity(NTU)	41.42	41.38	10
TDS (mg/l)	775.61	775.08	2000
pH	7.22	7.19	6.5-8.5
Hardness(mg/l)	1332.72	1334.49	600
Alkalinity(mg/l)	303.17	299.03	600
DO (mg/l)	6.97	6.96	5
BOD (mg/l)	15.03	15.02	5
COD (mg/l)	45.93	46.25	-
Chloride(mg/l)	684.51	674.48	1000
Phosphate(mg/l)	595.48	580.87	400
Sulphate(mg/l)	0.75	0.74	1.5
Nitrate(mg/l)	0.62	0.62	45
Fluoride(mg/l)	0.82	0.82	5

Table 1: Physicochemical parameters and their BIS limits

THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Escherichia coli		
Season	Radha kund	Shyam Kund
Pre Monsoon	+	+
Monsoon	+	+
Post Monsoon	-	-

Pseudomonas aeruginosa		
Season	Radha kund	Shyam Kund
Pre Monsoon	-	-
Monsoon	-	-
Post Monsoon	-	-

Salmonella typhi		
Season	Radha kund	ShyamKund
Pre Monsoon	-	+
Monsoon	-	-
Post Monsoon	-	-

Staphlococcus aureus		
Season	Radha kund	Shyam Kund
Pre Monsoon	+	+
Monsoon	+	+
Post Monsoon	-	-

Table 2: Pathogen presence during pre monsoon, monsoon and post monsoon in Radha and Shyam kund

Parameter	Radha kund			Shyam kund		
	Pre monsoon	Monsoon	Post monsoon	Pre monsoon	Monsoon	Post monsoon
TVC $*10^5$	60	90	40	66	103	44
TCC $*10^3$	36.00	68.00	32.00	41.00	84.00	31.00

Table 3: Total viable count and total coliform count for Radha and Shyam kund for all seasons

Parameter	Radha kund	Shyam kund
	R Value	R Value
Temperature (℃)	0.7639	0.799
pH	0.9058	0.9201
Turbidity(NTU)	0.9344	0.9419
Alkalinity(mg/l)	0.8112	0.8932
Hardness(mg/l)	0.1884	0.2932
Sulphate(mg/l)	0.8674	0.7431
Chloride(mg/l)	-0.1763	-0.2836
Fluoride(mg/l)	-0.6204	-0.2459
Nitrate(mg/l)	0.5641	0.6268
Phosphate(mg/l)	0.026	0.083
TDS (mg/l)	0.8955	0.8648
DO (mg/l)	-0.4113	-0.5381
BOD (mg/l)	0.7421	0.7871
COD (mg/l)	0.3995	0.341

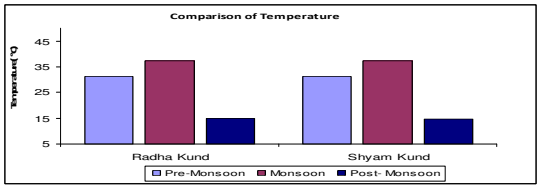
Table 4: Correlation study of TCC with physicochemical parameters

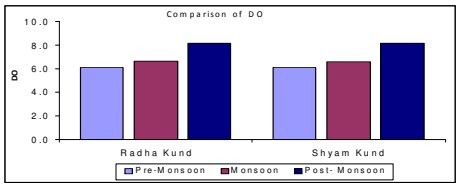
THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

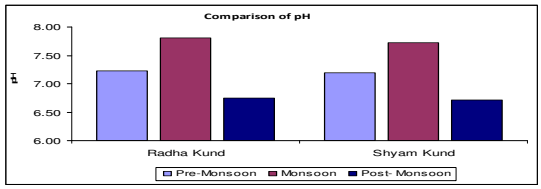
ISSN-2319-2119

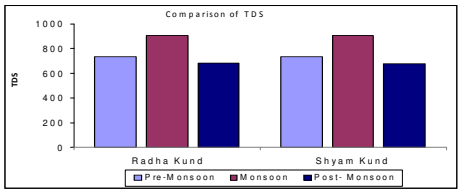
RESEARCH ARTICLE

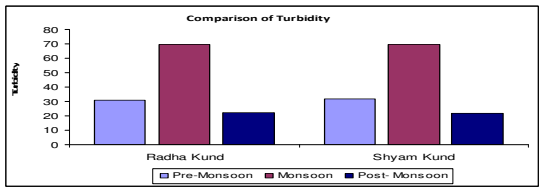
Maheepal Singh et al, The *Experiment, 2014, Vol.25(3)1726-1735*

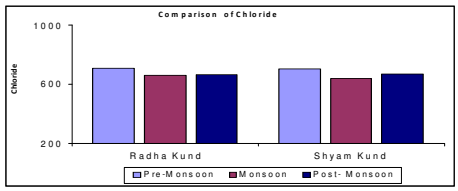


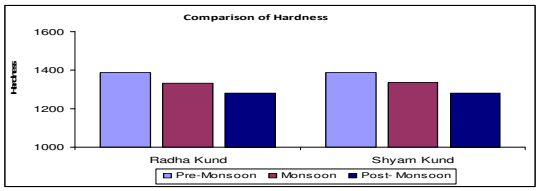


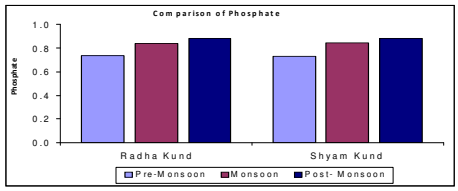


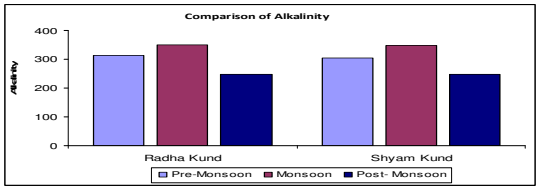


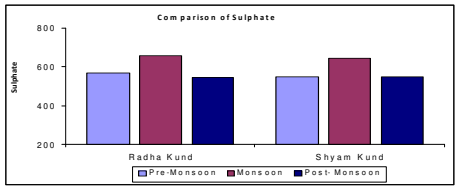


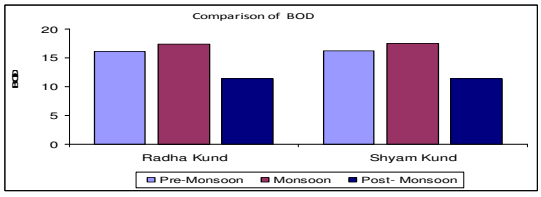


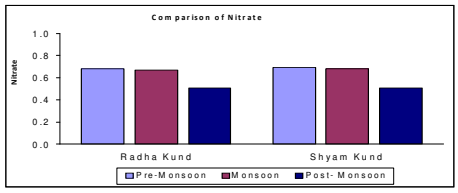


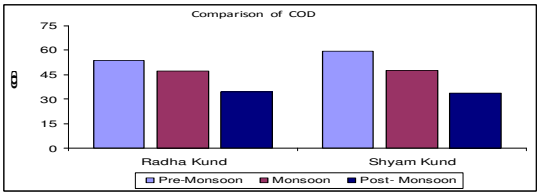


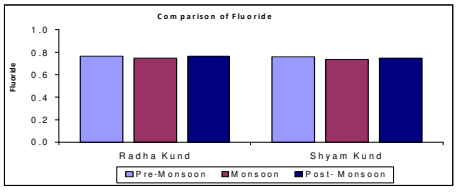












THE EXPERIMENT
INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN-2319-2119

RESEARCH ARTICLE

Maheepal Singh et al, The *Experiment, 2014, Vol.25(3)1726-1735*

Maheepal Singh and S.K Singh

Department of Zoology, M.S.J. Government Post Graduate College
Bharatpur, Rajasthan, India