



Research Paper

## ANALYSIS OF WATER OF PUSHKAR LAKE BEFORE, DURING AND AFTER THE PUSHKAR FAIR

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“Water is life” it means that “Jal hi jeevan hai”. All life on earth depends on water. It is nearly three quarters of the weight of a living cell, so the present study deals with comparative analysis of water of Pushkar Lake before, during and after the Pushkar fair. Pushkar lake is very holy and sacred lake situated in Ajmer. Pushkar fair held in kartik month. Seeing its use and significance, the Gau Ghat was selected for study. There are many parameter were studied in order to determine the status of the water of Pushkar lake such as temperature, pH, turbidity, transparency, acidity, alkalinity, biological oxygen demand, COD, dissolved O<sub>2</sub>, CO<sub>2</sub>, etc. The decrease in temperature during and after fair may be due to change in the weather. pH shows non-significant change. Acidity and Alkalinity after, during and after fair significantly. Transparency decreases and turbidity increases during fair because of the various religious rituals. Chloride content and salinity are increased during and after fair. Hardness of water increases because of the after effects of the pollution caused during the fair. BOD and COD values increases during fair and return near to values of before fair when the fair is over. Because of aesthetic importance the water of Pushkar Lake is very sacred. Therefore quality of water should be strictly maintained.

**Keywords:** Pushkar lake, Gau Ghat, Fair, Water pollution

### INTRODUCTION

Water along with land is the most important natural resource gifted to man by nature. The Proper combination of these two primary resources in space and time sets the upper limit of the population and carrying capacity of the area (Sharma et al., 1999). Water that is present in ponds, reservoirs, lakes or oceans for a

considerable period is called stored water. Once such body of stored water is the “Pushkar Lake” present in the very sacred town of Pushkar.

Pushkar Lake has mythological significance and is a touristic delight, a holy place where people come from all over the world. The Pushkar Lake is surrounded by 52 flights of steps called Ghats, many having special legendary importance. Each

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Ghat has its own miraculous qualities and power of healing. Because of such aesthetic importance, there is a steady flow of pilgrims throughout the year to Pushkar which is among the 5 principal places of Hindu pilgrimage. It is transformed into a bustling fair-ground in the month of Kartik (October-November) when the annual Pushkar Fair and the Cattle Fair are held simultaneously. Thousands of devotees can be seen taking dip in the holy lake on the full moon night.

Thus, keeping in mind the extreme aesthetic value of the Pushkar Lake, the effects of this water on the pilgrim's health and even on the health of the local public who use it regularly for various domestic purposes, the study of physico-chemical parameters of water of Pushkar Lake has been taken. The water samples collected from "Gau Ghat". The Gau Ghat had been chosen for sample collection because of its aesthetic value. Most of the pilgrims take the holy dip in the lake at this ghat.

## MATERIALS AND METHODS

The study was conducted during the period of October 2008 to November 2009. The samples were analyzed immediately for parameters, which need to be determined instantly and rest of the sample was refrigerated at 40°C to be analyzed later. For the estimation of DO and BOD, water samples were fixed at the sites. All the analysis methods followed standard procedures mentioned in "Standard Methods for Examination of Water and Wastewater 20<sup>th</sup> Edition (1998)," published by APHA, and "Chemical and Biological Methods for Water Pollution Studies" by Trivedi and Goel (1986). Temperature, transparency, turbidity, pH, specific conductivity, total dissolved solids (TDS), dissolved oxygen (DO), alkalinity,

chloride, sulphate, hardness, sodium, potassium, nitrate-nitrogen, biological oxygen demand (BOD), chemical oxygen demand (COD) and phosphates were the main parameters analyzed for assessment of nutrient sector.

## RESULTS AND DISCUSSION

The present study was conducted on water samples of the Gau ghat of Pushkar Lake, were collected from three consecutive days before the Pushkar Fair, three days during the fair, various physico-chemical parameters were analyzed on all the collected samples immediately. The average values of all the three days samples of before, during and after fair were calculated and were subjected to various standard statistical analyses to find out the correlation among these parameters.

The time chosen for collection of water samples from Pushkar Lake was usually morning time between 9.00 AM to 10.00 AM

The result revealed that the waste water from these industries with high value of BOD, TS, TN temperature conductance and nil or low value of DO and free CO<sub>2</sub> caused a marked ill effect on water quality.

### Temperature

Mean temperature of water collected before, during and after fair for sample was 25.33±2.31, 24.00 ± 1.0 and 20.00 ± 0.00°C (Tables 1 and 2). When the statistical analysis was done among before and during fair, there was a non-significant difference in the temperature. Highly significant decrease in the temperature was observed when results were compared before fair and after fair as well as during fair and after fair.

The decrease in temperature during and after fair may be due to change in the weather. Winter

**Table 1: Mean and Standard Deviation Values of Various Parameters Studied**

SAMPLE: (Gau Ghat)				
S. No.	Parameter	Before Fair (Mean $\pm$ SD)	During Fair (Mean $\pm$ SD)	After Fair (Mean $\pm$ SD)
1.	Temperature	25.33 $\pm$ 2.31	24.00 $\pm$ 1.00	20.00 $\pm$ 0.00
2.	Acidity	111.67 $\pm$ 33.29	43.33 $\pm$ 20.21	96.66 $\pm$ 50.08
3.	Alkalinity	31.67 $\pm$ 7.64	25.00 $\pm$ 5.0	4.33 $\pm$ 2.89
4.	pH	7.00 $\pm$ 0.00	6.67 $\pm$ 0.29	6.67 $\pm$ 0.29
5.	pH (pH meter)	6.63 $\pm$ 0.15	6.63 $\pm$ 0.15	6.57 $\pm$ 0.06
6.	CO <sub>2</sub> Content	61.6 $\pm$ 11.64	49.87 $\pm$ 18.32	101.2 $\pm$ 27.48
7.	Transparency	17.0 $\pm$ 1.5	15.33 $\pm$ 0.76	15.67 $\pm$ 0.76
8.	Chloride Content	39.29 $\pm$ 5.37	63.43 $\pm$ 6.71	47.80 $\pm$ 7.29
9.	Salinity	70.94 $\pm$ 9.71	114.51 $\pm$ 12.11	86.32 $\pm$ 13.15
10.	Hardness (Total)	43.33 $\pm$ 5.03	58.67 $\pm$ 20.43	58.0 $\pm$ 9.16
11.	Hardness (Permanent)	52.0 $\pm$ 4.0	70.67 $\pm$ 8.08	74.67 $\pm$ 6.43
12.	Turbidity	18.33 $\pm$ 0.58	20.00 $\pm$ 2.0	19.33 $\pm$ 0.58
13.	Sulphate	37.67 $\pm$ 0.58	38.66 $\pm$ 0.58	37.67 $\pm$ 0.58
14.	Fluoride	0.137 $\pm$ 0.00057	0.137 $\pm$ 0.001	0.1366 $\pm$ 0.0011
15.	Dissolved O <sub>2</sub>	5.13 $\pm$ 0.47	6.75 $\pm$ 0.47	4.86 $\pm$ 0.81
16.	Conductivity	755.67 $\pm$ 2.52	762.0 $\pm$ 1.0	757.67 $\pm$ 2.52
17.	BOD	36.78 $\pm$ 0.24	38.3 $\pm$ 0.20	36.87 $\pm$ 0.21
18.	COD	65.83 $\pm$ 0.11	66.30 $\pm$ 0.2	65.77 $\pm$ 0.11
19.	Phosphate	0.41 $\pm$ 0.0058	0.44 $\pm$ 0.01	0.41 $\pm$ 0.01

**Table 2: Statistical Analysis (t-Value and p-Value) of Various Parameters Studied Before, During and After Pushkar Fair of Sample (Gau Ghat)**

S. No.	Parameter	Statistical Analysis					
		Before V/S After Fair		Before V/S During Fair		During V/S After Fair	
		t-Value	p-Value	t-Value	p-Value	t-Value	p-Value
1.	Temperature	4.0	<0.001 (HS)	0.91	>0.05 (NS)	6.93	<0.001 (HS)
2.	Acidity	0.43	>0.05 (NS)	3.04	<0.01 (VS)	1.71	>0.05 (NS)
3.	Alkalinity	2.47	<0.05 (S)	1.26	>0.05 (NS)	5.50	<0.001 (HS)
4.	pH (pH meter)	0.00	>0.05 (NS)	0.64	>0.05 (NS)	0.64	>0.05 (NS)
5.	CO <sub>2</sub> Content	2.30	<0.05 (S)	0.94	>0.05 (NS)	2.69	<0.01 (VS)

Table 2 (Cont.)

S. No.	Parameter	Statistical Analysis					
		Before V/S After Fair		Before V/S During Fair		During V/S After Fair	
		t-Value	p-Value	t-Value	p-Value	t-Value	p-Value
6.	Transparency	1.72	>0.05 (NS)	1.37	>0.05 (NS)	0.55	>0.05 (NS)
7.	Chloride Content	1.63	>0.05 (NS)	4.87	<0.001 (HS)	2.73	<0.01 (VS)
8.	Salinity	1.69	>0.05 (NS)	4.87	<0.001 (HS)	2.73	<0.01 (VS)
9.	Hardness (Total)	2.43	<0.05 (S)	1.26	>0.05 (NS)	0.05	>0.05 (NS)
10.	Hardness (Permanent)	5.18	<0.001 (HS)	3.59	<0.001 (HS)	0.67	>0.05 (NS)
11.	Turbidity	2.13	<0.05 (S)	1.39	>0.05 (NS)	0.56	<0.05 (S)
12.	Sulphate	0.00	>0.05 (NS)	2.10	<0.05 (S)	2.10	>0.05 (NS)
13.	Fluoride	1.00	>0.05 (NS)	0.45	>0.05 (NS)	0.48	<0.01 (VS)
14.	Conductivity	4.04	<0.001 (HS)	0.97	>0.05 (NS)	2.77	<0.001 (HS)
15.	BOD	8.43	<0.001 (HS)	0.50	>0.05 (NS)	8.56	<0.001 (HS)
16.	COD	3.59	<0.001 (HS)	0.67	>0.05 (NS)	4.08	<0.001 (HS)
17.	Phosphate	4.54	<0.001 (HS)	0.00	>0.05 (NS)	3.70	<0.001 (HS)
18.	Dissolved O <sub>2</sub>	0.50	>0.05 (NS)	4.26	<0.001 (HS)	3.5	<0.01 (VS)

Note: NS – Not Significant; S – Significant; VS – Very Significant; and HS – Highly Significant.

season starts usually in November, (after Kartik Purnima). There's a general belief that when people take a holy bath in the Pushkar Lake on kartik Purnima (Full moon day in November), the cold weather begins in this part of Rajasthan.

### Acidity

Mean acidity of water before, during and after the fair for was  $111.67 \pm 33.29$ ,  $43.33 \pm 20.21$  and  $96.66 \pm 50.08$  (Table 1). The statistical analysis of the acidity before and after the fair and during and after the fair shows a non-significant difference. When results before the fair and during the fair were compared, they showed a very significant difference (Table 2).

Acidity could have decreased during the fair due to various reasons. The huge number of

baths being taken by pilgrims at the Ghats, usage of soaps and detergent, performance of religious rituals and deposition of various articles in the lake like food for fish, flowers, lamps, etc. may have given rise to various reactions that bring down the acidity of water. The acidity after the fair returns to near about the same value as it was before the fair.

### Alkalinity

Mean alkalinity values for sample before, during and after the fair was  $31.67 \pm 7.64$ ,  $25.0 \pm 5.0$  and  $43.33 \pm 2.89$  (Table 1). The statistical analysis of the alkalinity before and after the fair shows a significant difference whereas the results of before and during the fair shows no significant difference. The analysis of results during and after

the fair show a highly significant increase in alkalinity (Table 2).

Alkalinity does not showed a significant difference before and during the fair but after the fair it increases greatly. It may be due to the usage of various types of soaps and detergents for bathing and the washing of cloths by the people. The number of people using the lake's water for the above activities increase greatly during the fair and the increase in alkalinity may be one of the after- effects of the fair.

### pH

The mean pH of the water collected from Gau Ghat before, during and after the fair was  $6.63 \pm 0.15$ ,  $6.63 \pm 0.15$  and  $6.57 \pm 0.06$  (Table 1).

The statistical analysis shows non-significant differences between the pH values before and after the fair before and during the fair and during and after the fair for the sample (Table 2).

pH values though showed a slight variation but does not represent a significant difference. It may be assumed that though pH is varying but the variation is not good enough to make a marked difference. Further there is constant addition of fresh water from pumps contributes no alternation in pH.

### CO<sub>2</sub> Content

The mean values of CO<sub>2</sub> content for sample before, during and after the fair were  $61.6 \pm 11.64$ ,  $49.87 \pm 18.32$  and  $101.2 \pm 27.48$  (Table 1). Statistical analysis of the values before and during the during the fair showed a non-significant change. The results of during fair when compared with after fair were very significantly increased (Table 2).

The significant variation in the CO<sub>2</sub> content could have because of the formation and break up of various carbonates and bicarbonates as result of the various kinds of material that come into the lake during the fair.

### Transparency

The transparency of the sample before, during and after the fair was  $17.0 \pm 1.5$ ,  $15.33 \pm 1.76$  (Table 1). The results when compared for before and after and before and during fair for both samples and during and after fair for sample were non-significant.

Gau Ghat (site for sample) is the most important spot for the pilgrims. So, the Government must be observing various measures and checks to at least maintain the minimum standards for water here. So, the water physically does not appear much contaminated.

### Chloride Content

The mean chloride content for sample before, during and after the fair was  $39.29 \pm 5.37$ ,  $63.43 \pm 6.71$  and  $47.80 \pm 7.29$ .

The analysis of results before and after fair for sample shows non significance.

The significantly increased chlorinity of water of Pushkar Lake during the fair may be because of the addition of chloride to the water by the public health, authorities in order to maintain a level of cleanliness of water.

The further decrease in the chlorinity may have occurred due to the various types of ways the water was being used at the Gau Ghats during the fair.

### Salinity

The salinity for sample before, during and after the fair was  $70.94 \pm 9.71$ ,  $114.51 \pm 12.11$  and  $86.32 \pm 132.15$ .

Salinity has an empirical relationship with the chlorinity of water. So as chlorinity changes, the salinity also changes.

### **Hardness (Total)**

The mean hardness (total) for sample were  $43.33 \pm 5.03$ ,  $58.67 \pm 20.47$  and  $58.0 \pm 9.16$  respectively (Tables 1 and 2).

Hardness of water usually increased during fair and after fair. The results before the fair point towards the hard nature of water i.e. its hardness that may be one of its usual properties. During the fair there is no significant variation in the hardness but after the fair the hardness shows significant increase that may be because of the after effects of the pollution caused to the lake during the fair.

### **Hardness (Permanent)**

The mean hardness (permanent) for sample was  $52.0 \pm 4.0$ ,  $70.67 \pm 8.08$  and  $74.67 \pm 6.43$  (Table 1).

The highly significant change in the permanent hardness of water during the fair may have occurred because of the increase influx of various compounds that cause permanent hardness like sulphates and the chlorides of various metals. But after the fair this type of hardness decreases and tries to acquire its previous state.

### **Turbidity**

The turbidity values for sample before, during and after the fair were  $18.33 \pm 0.58$ ,  $20.00 \pm 2.0$  and  $19.33 \pm 0.58$  (Table 1).

Turbidity is inversely proportional to the transparency. So, as transparency changes, the turbidity also changes. Turbidity increase because of the increase in suspended matter like clay, slit, organic matter, planktons and other micro-organisms.

### **Sulphate**

The mean sulphate contents before, during and after the fair for sample (A) were  $37067 \pm 0.57$ ,  $38.66 \pm 0.57$  and  $37.67 \pm 0.57$  (Table 1).

Sulphate was found in higher concentration particularly in arid and semiarid region and Rajasthan was considered as an arid region so this may be reflected in the chemical makeup of the various water bodies of Rajasthan. Sulphate concentration also changes due to accumulation of soluble salts.

### **Fluoride**

The mean values of fluoride content for sample before, during and after the fair were  $0.137 \pm 0.001$ ,  $0.137 \pm 0.001$  and  $0.136 \pm 0.001$ .

Pushkar Lake is Ground water so the fluoride content shown what is actually the fluoride content of that ground water. The externally added water may not be showing an increase in the fluoride content.

### **Conductivity**

The mean conductivity of sample before, during and after the fair was  $755.67 \pm 2.52$ ,  $762.0 \pm 1.0$  and  $757.67 \pm 2.52$ . The statistical analysis shows a highly significant change for the samples before and during the fair, non significance for the samples after and during the fair.

Electrical conductance is the ability of a substance to conduct electric current. It is the property caused by the presence of various ionic species and the variation shown in the conductivity may be because of the disturbance of the level of concentration of the various ionic species.

### **Biological Oxygen Demand**

The mean BOD values for the samples before, during and after the fair were  $36.78 \pm 0.24$ ,

38.3 ± 0.2 and 36.87 ± 0.21. The results analysis shows non-significance for the samples for during and before comparisons. It shows high significance for sample before and after comparison and during and after comparison for sample (Table 2). BOD approximates the amount of oxidizable organic matter present in the water. BOD can be used as a measure of waste strength. So, the BOD values fluctuate according to the waste strength of the water of Pushkar Lake.

## CHEMICAL OXYGEN DEMAND

The mean COD values for sample before, during and after the fair were 65.83 ± 0.11, 66.30 ± 0.2 and 65.77 ± 0.11 (Table 1).

COD is the oxygen required by the organic substances in water to oxidize them by a strong chemical oxidant. Toxins and micro-organisms may vary the values of COD as may have been the case here.

## Phosphate

The mean Phosphate content for sample before, during and after the fair was 0.41 ± 0.006, 0.44 ± 0.01 and 0.41 ± 0.01 (Table 1). The result was highly significant for sample before and after and during and after comparisons.

Major sources of phosphates are domestic sewage, detergents, agricultural effluents with fertilizers and industrial waste water. In the presence of oxygen, phosphate co-precipitates with the complex insoluble oxides of various matters and thus composes the phosphate content of the water.

## Dissolved Oxygen

The values for dissolved oxygen for sample before during and after the fair were 5.13 ± 0.47, 6.75 ± 0.47 and 4.86 ± 0.81 (Table 1). The statistical analysis shows non significance and high significance and very significant variation in the before and after; before and during, and during and after comparisons respectively (Table 2).

The dissolved O<sub>2</sub> contents after fair are reduced. Dissolved oxygen depends on the organic substances present in the water. The concentration of such substances varies at the different stages, i.e., before, during and after the fair and so does the value of dissolved oxygen.

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