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Effect of '*Pushkaram*' Activities on Quality of Krishna River Water - A Study Based On Determination of Residual Chlorine

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Abstract— *The present study is aimed at evaluating the quality of Krishna river water before and after the 'Pushkaram' celebrations organized in and around Vijayawada, Andhra Pradesh, India during 11th to 24th August 2016. These celebrations generally involve activities that significantly pollute water. The study was carried out by collecting water samples before and after the period mentioned above at different locations where celebrations were organized. In order to analyze the samples, breakpoint chlorination technique was used apart from the determination of various quality parameters of water samples using both volumetric and instrumental methods of analysis. The study indicates that there is significant effect of the activities of pushkaram celebrations on the quality of water in spite of many measures taken by the concerned authorities.*

Keywords— Water quality, Krishna river, Chlorine demand, Pushkaram activity, Vijayawada.

I. INTRODUCTION

Water is a prerequisite for the performance of any '*Hindu*' ritual, whether it takes place in temples or in homes. Within the complex Hindu dichotomy of sacred and profane, flowing water is believed to have weightened spiritual attributes. Rivers remove dirt and other impurities as well as they have ability to draw in fresh potency. According to Hindu culture, it is believed that a dip in holy river expiates sins of human beings and also capable of relieving oneself from cycle of repeated births. Further, the ashes of a deceased person, after cremation, are immersed in a river so that it can facilitate the soul's journey to its transcendent source [1]. 'Pushkaram' is a Hindu bathing festival celebrated once every twelve years at each of the twelve major rivers of India. It is a powerful expression of Hindu piety where devotees engage in auspicious activities to gain spiritual merit. Millions of pilgrims arrive at temple towns along the course of these rivers to participate in the celebrations [1]. Pushkaram is celebrated when the planet Jupiter transits into different astrological signs. It is believed that deities and ancient rishis bathe in the river at the time of pushkarams. Hence, people who bathe in the specific rivers in specific duration (particularly first 12 days), perform various rituals and worship, offerings to ancestors, are said to gain great benefits [2].

Krishna river is the third longest river in India that flows in central-southern India. It originates in Maharastra state, flows through Karnataka state and meets Bay of Bengal at Hamsaladeevi in Andhra Pradesh state, covering a total distance of about 1400 km. This river gets pushkaram when Jupiter enters the zodiac house 'Virgo'. Recently, Krishna pushkaram celebrations were conducted from 12th to 23rd August 2016. The locations along the river where the facilities for holy dip of thousands of devotees are provided are called '*Ghats*'. During the Krishna pushkaram celebrations-2016, the ghats were constructed at different places along the river in Andhra Pradesh state. But, the major ghats provided were in and around Vijayawada city. In the present study, the Krishna river water samples were collected from different ghats before (11th August 2016) and after (24th August 2016) the pushkaram celebrations, various quality parameters were determined and the amounts of residual chlorine in case of all the water samples were determined. There are several literature reports in which the residual chlorine determination is used in the study of water quality [3-5]. Based on the results, the effect of the celebrations on water quality was analyzed.

II. MATERIALS AND METHODS

The water samples were collected before and after the pushkaram celebrations of Krishna river in and around Vijayawada city, Andhra Pradesh. The ghats at which the samples were obtained are Sangamam, Ferri, Tummalapalem, Surayapalem, Gollapudi, Bhavani and Thallayapalem. The water quality parameters, viz., electrical conductivity, pH and turbidity were determined by using corresponding instruments and the parameters namely alkalinity, hardness and chlorides were determined by conventional volumetric analysis. The

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quantity of total dissolved solids (TDS) was obtained by gravimetric method.

The residual chlorine after treatment of water samples with chlorine was determined by iodometric titration method. In this method, 500 mL of water sample is taken in air-tight glass bottle and the pH is adjusted to 6.0 by the addition of 0.1 N H_2SO_4. After each addition of chlorine to water sample, the residual chlorine remaining in water sample was determined by using standard sodium thiosulphate solution and starch solution as the indicator. The quantity of chlorine corresponding to breakpoint in the graph drawn between chlorine added and residual chlorine was determined for all the water samples.

III. RESULTS AND DISCUSSION

The water quality parameters of all the samples collected before and after pushkaram celebrations are shown in Tables 1 to 3 and Fig. 1.

Table.1: Alkalinity and hardness values of water samples collected at different ghats before and after celebrations

Ghat	Alkalinity (ppm)		Hardness (ppm)	
	Before	After	Before	After
Sangamam	146	189	156	145
Ferri	160	177	151	162
Tummalapalem	155	159	146	145
Surayapalem	174	188	180	175
Gollapudi	189	206	165	177
Bhavani	169	188	146	156
Thallayapalem	233	274	175	177

The alkalinity values are found to be slightly higher for water samples obtained after the activities of pushkaram celebrations when compared with those before the celebrations, however, the increase is found to be very slight. Similar trend is observed in case of hardness also. The increase in the values of alkalinity and hardness is also reflected in the increase in electrical conductivity of the samples after the activities of celebrations. The parameters namely pH and chlorides are found to be slightly increased in case of some samples and slightly decreased in others.

Table.2: Electrical conductivity and pH values of water samples collected at different ghats before and after celebrations

Ghat	EC (µS)		pH	
	Before	After	Before	After
Sangamam	570	595	7.55	7.85
Ferri	540	555	7.40	7.24
Tummalapalem	538	610	7.82	7.55
Surayapalem	533	549	7.68	7.41
Gollapudi	546	598	7.74	7.68
Bhavani	581	622	7.82	7.93
Thallayapalem	632	651	7.81	7.54

Table.3: Chlorides and turbidity of water samples collected at different ghats before and after celebrations

Ghat	Chlorides (ppm)		Turbidity (NTU)	
	Before	After	Before	After
Sangamam	59	55	0.518	1.258
Ferri	53	50	0.207	0.855
Tummalapalem	51	49	0.829	1.925
Surayapalem	56	55	0.328	1.029
Gollapudi	61	63	0.138	0.741
Bhavani	59	68	0.414	1.116
Thallayapalem	78	73	1.279	1.845

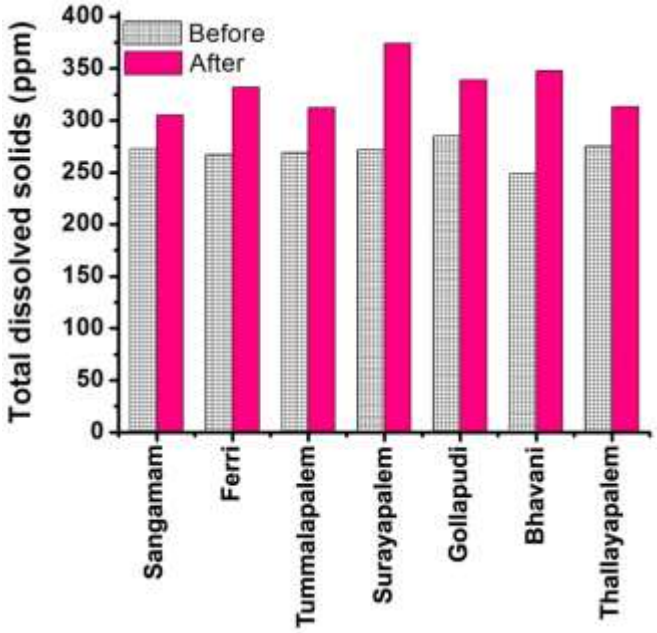

Fig.1: Total dissolved solids (TDS) of water samples collected at different ghats before and after celebrations

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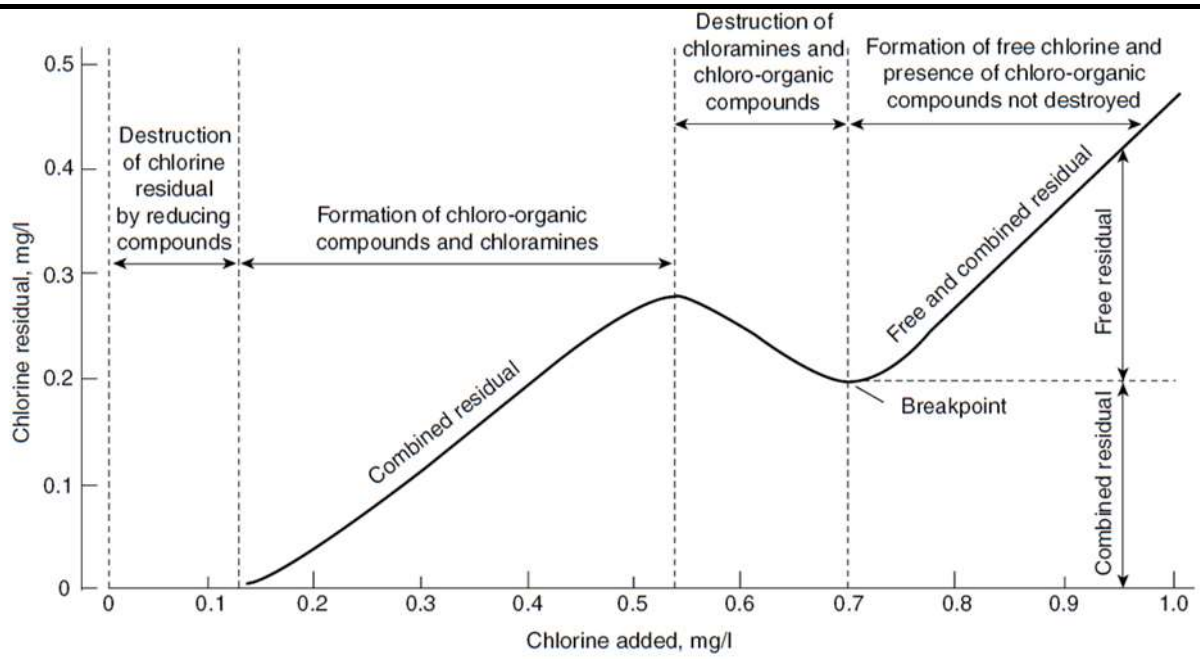

Fig. 2: Typical breakpoint chlorination curve

The turbidity and TDS values are higher for all the water samples after celebrations, as inferred from Table 3 and Fig. 1 respectively. These results indicate that the activities associated with the celebrations do not affect much with reference to the pH, conductivity, alkalinity and chlorides, whereas significant effect is observed in case of turbidity and total dissolved solids.

A significant aspect to be mentioned here is that the religious activities associated with pushkaram celebrations involve offering flowers, fruits, cooked rice and other grains, leaves, etc. to the river water, as a part of worshipping the river. Hence, most probable impurities expected to be present in river water during pushkaram activities are organic.

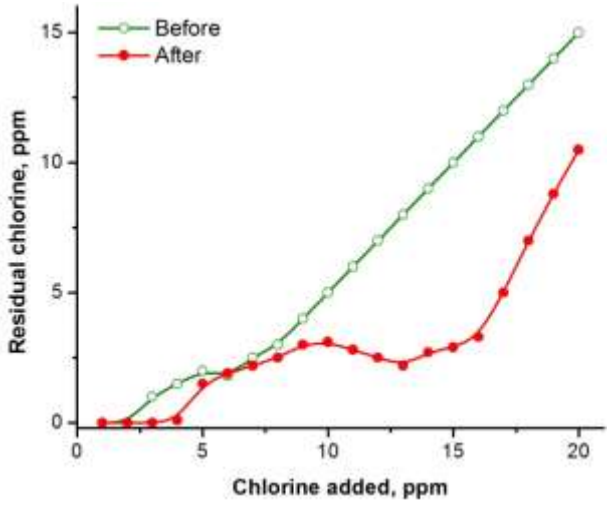

Fig.3: Breakpoint chlorination curves for water sample at Sangamam ghat before and after the activity

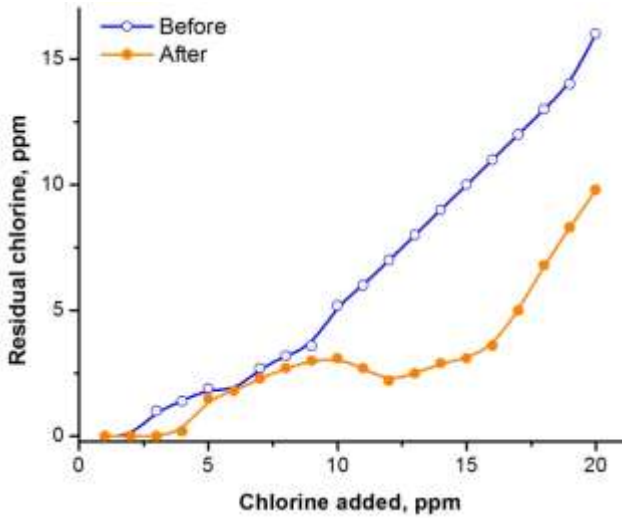

Fig. 4: Breakpoint chlorination curves for water sample at Ferri ghat before and after the activity

In this background, it is appropriate to study the levels of impurities in such water samples by using the chlorine demand by water samples before and after the activity. Hence, breakpoint chlorination curves were plotted for all the water samples collected. The breakpoint chlorination graphs obtained in case of all the water samples before and after the pushkaram celebrations are shown in the Figs. 3 to 9. From these figures, it can be observed that all the water samples initially required a minimum of 2 ppm of chlorine, except that at Thallayapalem ghat, without leaving any solid residue before the event. The sample at the Thallayapalem ghat before the event required 1 ppm, but after the addition of 1 more ppm of chlorine, the residual chlorine was found to be 0.5 ppm. This result can

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be due to constant levels of reducing substances that can be oxidized by the added chlorine. But, when the chlorine demand for reducing substances is considered after the event, it was 3 ppm for the samples at Sangamam, Ferri, Thummalapalem and Surayapalem ghats, while it is 1.5, 0.3 and 0.2 ppm for Gollapudi, Bhavani and Thallayapalem ghat samples respectively. Once, the appearance of residual chlorine is started, it has been gradually increased for all the samples before and after the event. In case of pre-event, it is in the range 1.9 to 2.4 and in case of post-event, it is 1.6 to 4.0. It infers that there are significant amounts of organic impurities in water after the event, which consumed more amount of chlorine to for corresponding chloro-organic compounds. It is well-known that the amount of chlorine required for formation of these compounds is always less than that required for destruction/decompoisiton of these compounds.

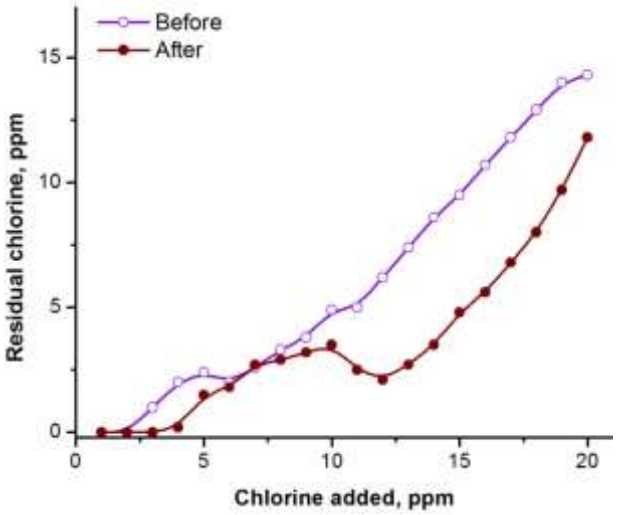

Fig. 5: Breakpoint chlorination curves for water sample at Thummalapalem ghat before and after the activity

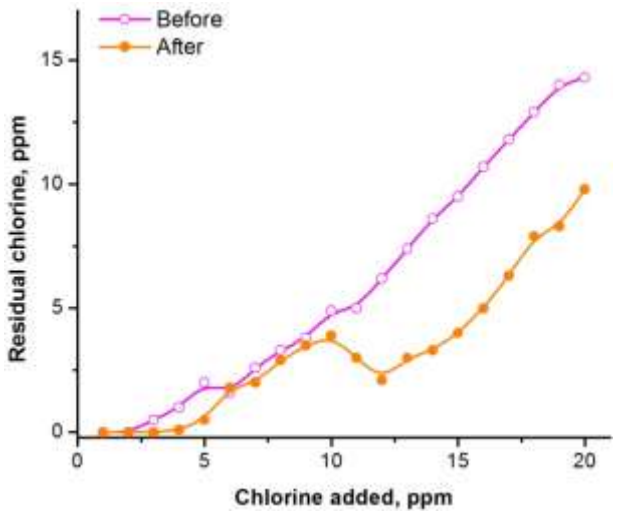

Fig. 6: Breakpoint chlorination curves for water sample at Surayapalem ghat before and after the activity

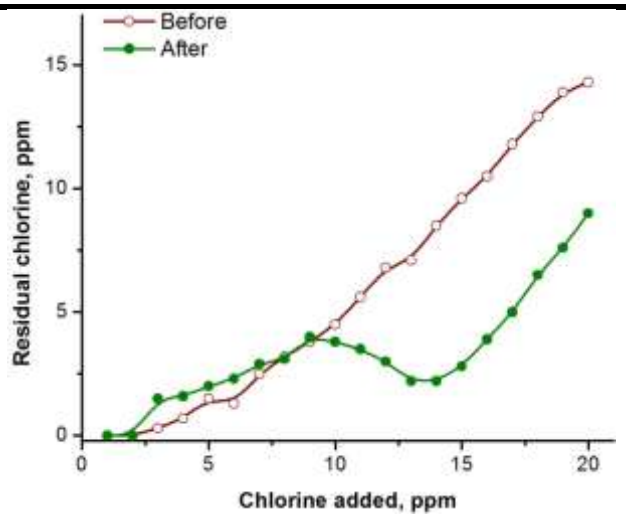

Fig. 7: Breakpoint chlorination curves for water sample at Gollapudi ghat before and after the activity

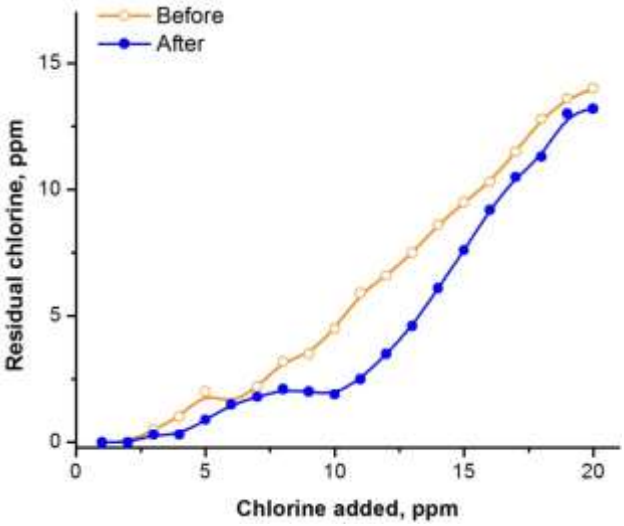

Fig. 8: Breakpoint chlorination curves for water sample at Bhavani ghat before and after the activity

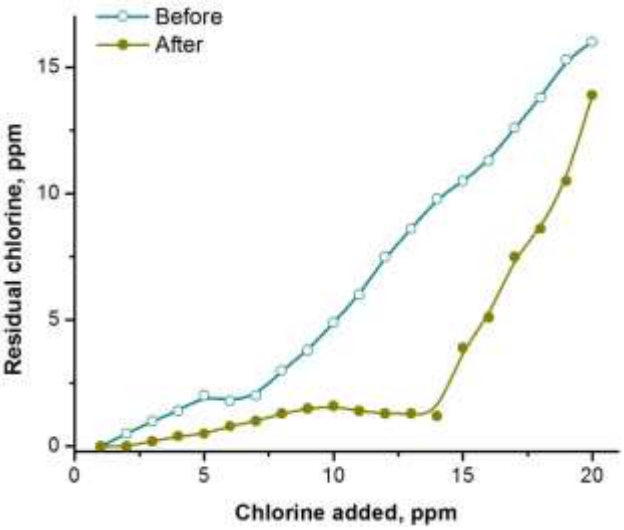

Fig. 9: Breakpoint chlorination curves for water sample at Thallayapalem ghat before and after the activity

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Table.4: Amount of chlorine corresponding to breakpoint for all the water samples before and after the activity

Ghat	Quantity of chlorine corresponding to breakpoint (ppm)	
	Before	After
Sangamam	6.0	13.0
Ferri	6.0	12.0
Tummalapalem	6.0	12.0
Surayapalem	6.0	12.0
Gollapudi	6.0	14.0
Bhavani	6.0	10.0
Thallayapalem	6.0	14.0

Table 4 indicates that the dosage of chlorine corresponding to breakpoint is 6.0 ppm for the water samples collected at all the ghats before the event. But, after the event, it is in the range 10.0 to 14.0 ppm. It indicates that all the water samples are contaminated by organic impurities like cooked food grains, leaves, residues of fruits and flowers, etc. which were added by devotees as a part of celebrations. This inference is supported by variations in the water quality parameters listed above in the Tables 1 to 3 and Fig. 1. In fact, the celebration authorities took all the necessary measures to provide fresh water every day for the celebrations by replacing the contaminated water with fresh water. Further, larger suspended impurities were removed as frequently as possible and bleaching powder was used in the cleaning process of the premises of celebrations. In spite of these precautions and measures, the river water was contaminated to a considerable extent.

IV. CONCLUSION

The study indicates that the Krishna river water was considerably contaminated by the activities of the pushkaram celebrations as inferred by the determination of residual chlorine for the water collected at different locations of the celebrations. However, the contamination is found to be very less than expected from various activities leading to continuous heavy contamination throughout the period of 12 days. It is due to all the necessary precautions and measures taken by the concern authorities of celebrations by way of replacement of contaminated water with fresh water on a daily basis, removal of large suspended impurities and residues form contaminated water frequently and cleaning the locations of celebrations using bleaching powder. From the present study, it can be concluded that the technique of breakpoint chlorination is an effective way of analyzing the contamination of water samples, particularly when the impurities are organic compounds.

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