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Impact of Idol Immersion Activities Leading to Deterioration of Water Quality

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Abstract
Ganesh Chaturthi is one of the main festivals through celebrated across all over India, but majorly in western part of India. After certain period of days, idol is immersed in nearby water bodies every year. As the number of Idol immersion rises every year with the increasing population with finite water bodies hence water pollution gradually increases, which is the frightening situation. In present study, water samples were collected from the upstream of Mindhola river, Gujarat, India. The physicochemical analysis of water samples were performed for Total Solids, pH Value, Boron (B), Nitrogen based compound Ammonia (NH_3), Chlorine (Cl^-), Sulphate (SO_4^{2-}), Lead (Pb), Chromium (Cr) and Zinc (Zn). The results obtained reveals that river water becomes acidic after idol immersion. The trend of increase in such parameters indicates that idol immersion affect the water quality to the extent with respect to self deterioration of water and flow of water stream of the river. On the basis of these parameters it is concluded that level of water pollution increases in Mindhola river, due to these religious activities and it causes adverse effect on the aquatic ecosystem. No one can stop these religious activities but creating awareness among the people and society can reduce the pollution.

Keywords: *Ganesh Chaturthi, Idol immersion, Water pollution, Mindhola river, Physicochemical analysis, Deterioration.*

1. Introduction:

India is a multicultural country with great diversity of people celebrating manifold festivals. Some of these festivals involves ‘idol immersion’ in water bodies as the final celebration. Beautifully carved and furbish idols are inundate into water bodies like ponds, rivers, lakes with invocation for success, peace and happiness. One of the major occasion in India that involves the idol immersion in Ganesh Chaturthi is devoted to lord Ganesh. Ganesh Chaturthi is also known as Vinayaka Chaturthi; is one of the most sacred Hindu festival celebrated throughout the India with great enthusiasm. Devotee’s bring the idols for few days and immerse them in rivers, lakes or sea since decades. In past the idols were made of clay and the size of models varied from few inches to about 30 feet. On the final day the idols are taken out in colorful and musical procession and immersed in water traditionally. However the difficulties arisen due to emergence of new materials like Plaster of Paris (P.O.P), plastic, cement in constructing idols as well as low water levels especially for the large size idols during the immersion embarks the difficulties during the festivals. In addition the noxious paints which are used to decorate the idols leads to massive environmental pollution as idols are decorated with different paints such as varnish, water colors, etc. which might lead to significant alteration in the quality of water. Paints which are used to colour these idols contains numerous heavy metals such as Zinc, Chromium and Lead. More specifically red, blue, orange and green colour contains Zinc oxide, Chromium and lead, which are potential carcinogens. Heavy metals such as Lead, Chromium also added in water bodies through Sindoor (Red color cosmetic powder) (Bhattacharya *et. al.*, 2014). The floating materials which are released from idols in water bodies, after decomposition results in eutrophication, elevating the acidity and concentration of heavy metals. Heavy metals causes negative impact on aquatic ecosystem as it kills fishes varying aquatic plants, interrupting the natural flow of water and damaging its natural environment.

Major problem with these new materials is they do not completely disband in the water after the immersion. A lot’s of realization and implementation as preventive measures are taken in account, however with the number involved, these efforts have no impact yet. Idol made of Plaster of Paris (P.O.P.) are the major culprit in disturbing the water

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domain. Studies reveals the impact of Plaster of Paris (P.O.P.) based idol immersion has been fetch in various place in our country including Gujarat, Bhopal, Jabalpur and Bengaluru which have showed several noteworthy impact like vertiginous rise in the concentration of metals like lead [Pb], zinc [Zn], and chromium [Cr]. Along with it increased levels of dissolved solids, acidity and considerable drop in dissolved oxygen have also been reported. The issues of water have become increasing important to environment particularly in concern to human health and food security (Kaur *et. al.*, 2012). According to the basic chemistry, P.O.P. is made from Gypsum (A sediment used in making P.O.P. and fertilizers), when P.O.P. comes in contact with water, the material retrieve the form of gypsum. It causes steep rise in water hardness and diminish the aquatic life carrying capacity. Sulphate is the main component of effluent waste; although P.O.P. is being used for idols, it is the crucial source of sulphate. The increase in the concentration of the sulphate in water leads to dehydration, diarrhoea and intestinal discomfort (Rose and Cravotta *et. al.*, 1998). The uncontrolled load of nitrogen based compounds, feed the weeds and algae in the reservoir, due to which anaerobic microorganisms discharge toxic compounds including ammonia (NH_3), which is toxic to fish and it reduces the food chain efficiency (Kirti *et. al.*, 2008). The increase in the boron concentration is examined as a consequential threat for the use of water in both drinking and agriculture purpose (Chaudhary *et. al.*, 2010). Chlorides is usually not harmful to the people, but sodium being the part of the common salt has been linked to heart and kidney disease, as the high chloride content reacts with the sodium and makes the water taste salty; it may also rise the TDS content values of water (Malik *et. al.*, 2012). The aim and need of the study is to emphasize on a risk assessment of unknown threat to human consumption of water containing such contaminants as well as to the ecosystem of water reservoir.

2. Materials and Methodology:

Study site:

Collection of water sample was done from the upstream of Mindhola River (encircled with red colour) which is located in the western India in Gujarat and it originates near Doswada, Songadh. Its basin has a maximum length of 105 Km and the total catchment area of basin is 586 sq. meters as shown in figure-1.

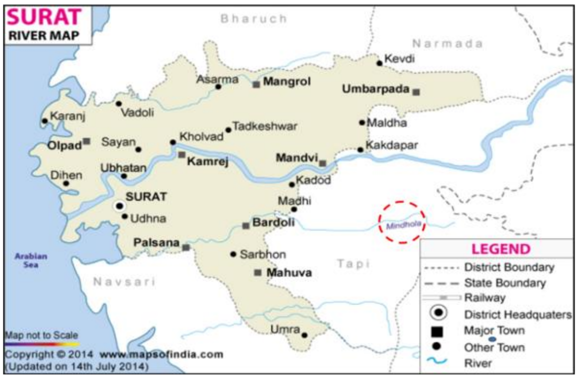

Figure:- 1 Map of Study Area

Idol Features:

Plaster of Paris (P.O.P.) Idol was procured from the local market and Clay Idol procured from State Govt. Municipal Corporation. The physical characteristics were distinguished on the basis of their weight, colour, and various material components.

Figure:- 2 Ganesh Idols Before Immersion

Table 1: The Physical Features of idols

Idol features	P.O.P	Sand
Height (cm)	31.5	30.5
Weight (lbs)	4.41	7.71
Base	Sea green	Sky blue
Ornaments	Golden	Golden
Colour	Chemical	Natural

Chemical Analysis of Water Samples:

Water samples were collected during pre and post immersion of Idols and the physicochemical analysis of water sample were performed following the standard procedure of Total Solids, pH Value, Boron (B), Nitrogen (Ammonia), Chlorine (Cl^-), Sulphate (SO_4^{2-}), as described in Guide Manual: Water and Waste Water Analysis, Central Pollution Control Board (A Govt. of India Organisation), Ministry of Environment and Forests. For the analysis of Lead (Pb), Chromium (Cr) and Zinc (Zn) were performed through Atomic Absorption Spectroscopy (AAS) at Man-Made Textile Research Association (MANTRA), Surat.

pH Value Analysis by Electrometric Method:

Calibration of pH meter using standard buffer soultion was carried out. The pH of samples were determined and readings were recorded acccordingly.

Total Solids

(a) **Total Solids:** Samples of known volume taken in porcelain dish with weight (W_1) were placed in hot air oven for complete drying at a temperature of 105 ºC for 24 h. The samples were allowed to cool in desiccator and weigh the porcelain dish, weight (W_2) was recorded in observation table.

Total Solids = $W_2 – W_1$

(b) **Total Dissolved Solids:** Samples of 100 mL each were filtered using Whatmann paper no. 1, filter paper containing residues (W_1) were weighed and placed in hot air oven and dried it at temperature of 180 ± 2 ºC, the filter paper were allowed to cool in a dessicator and weigh it, Weight (W_2) was recorded in observation table.

Total Dissolved Solids = $W_2 – W_1$

Ammonia (NH_3) Analysis by Nesslerisation Method:

For spectroscopic analysis, 1 mL of $ZnSO_4$ ($ZnSO_4.7H_2O$- 10 g, D.w.- 100 mL) solution added to 100 mL of sample and 0.5 mL of 6N NaOH used to adjust the pH 10.5 for precipitation of elements like calcium, magnesium and iron. After filtration, 2 drops of EDTA was added to filtrate and agitated; 3 mL of Nessler reagent was further added to the mixture and make the final volume 100 mL with distilled water. Blank was prepared in same manner by taking distilled water instead of sample. Absorbance was taken after 10 minutes at 410 nm.

Chlorine (Cl^-) Analysis by Argentometric Method:

For Argentometric analysis, 1M NaOH used to adjust 50 mL sample to pH 8 and 1 mL of $K_2Cr_2O_7$ ($K_2Cr_2O_7$- 50 g, D.w.- 100 mL) was added subsequently. Titration with the standard solution of 0.0141 N $AgNO_3$ until brick pale red precipitate of $AgCrO_4$ is observed. Blank was prepared in same manner.

Calculation:

Chloride mg/L as

Cl^- = (A-B) x N x 35.45 x 1000 /mL sample.

Where,

A= mL of $AgNO_3$ required for sample.
B= mL of $AgNO_3$ required for blank.
N= Normality of $AgNO_3$.

Boron (B) Analysis by Curcumin Method:

For standard graph, pipette 0 (Blank), 0.25 mL, 0.50 mL, 0.75 mL, 1 mL of boron solution (1 mL = 100 µg) while for sample treatment, pipette 0 (Blank), 0.25 mL, 0.50 mL, 0.75 mL, 1 mL of water samples and make the final volume 1 mL with distilled water in petri dish. Curcumin reagent (Curcumin- 40 mg, Oxalic acid- 5 g, Conc. HCl- 4.2 mL, Ethyl alcohol- 80 mL; final volume 100 mL was made with ethyl alcohol) of 4 mL was added to each volume and mixed continuously by swirling. The mixture was allowed to dry in hot air oven 55±2 ºC for 80 minutes. Petri dish were allowed to cool at room temperature, 10 mL of 95% ethyl alcohol was added for the complete dissolution of red coloured product. Solution of different petri dish were collected in separate flask by washing the petri dish with 95% ethyl alcohol. Absorbance of standard and samples were recorded at 540 nm after setting reagent blank at zero absorbance.

Suphate (SO_4^{2-}) Analysis by Turbidimetric Method:

For analysis, 10 mL of water samples were taken into a 250 mL Erlenmeyer flask and final volume to 100 mL was made with distilled water. Subsequently, 20 mL of buffer solution was added to the flasks and mixed well by stirring constantly with the help of stirrer; 1-spatula $BaCl_2$ was added in stirring condition, kept the solution for 1 minute until $BaCl_2$ gets dissolved. Blank was prepared similarly without adding $BaCl_2$ to the solution. Absorbance was recorded at 420 nm after setting reagent blank at zero absorbance.

Heavy metal Analysis by AAS technique:

The analysis for the majority of trace elementes like Lead (Pb), Chromium (Cr) and Zinc (Zn) of standard solutions and water samples was done by flame Atomic Absorption Spectrophotometer at MANTRA, Surat. The calibration curves was prepared separately for all the above metals by known standard

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concentration of respective elements. A reagent blank of sample was also taken, detected and subtracted from the samples to correct for the reagent's impurities and other possible source of errors from the environment. Average values of three replicates were taken for each analysis.

3. Results and Discussion:

Ganesh idol of P.O.P. and Clay were procured from local market as well as State Govt. Municipal Corporation were immersed into transparent container having water collected from Mindhola river as shown in figure- 3(a) and 3(b) and that water was used as a sample for further analysis.

Figure: 3(a) Immersion of Idols (P.O.P. and Clay)

Figure: 3(b) Post-immersion of Idols (P.O.P. and Clay)

pH Value Analysis by Electrometric Method:

The pH of water is important because it affects solubility of nutrients. In water samples for pre-immersion pH 8.56 varied to pH 7.75 in water samples for post-immersion of idol (Clay), while pH 7.2 in water samples for post-immersion of idol (P.O.P.); lowering of pH has been observed as shown in figure-4 and in Table-2. The changes in pH might be due to the addition of organic matter and material used in the preparation of Ganesh idols.

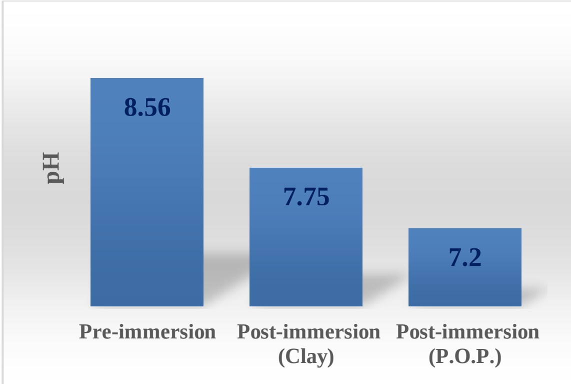

Figure: 4 Graph of comparative pH values of water samples

Total Solids:

Total solids and Total dissolved solids in water samples for post-immersion of idol (Clay) increased by 17% and 1.24% respectively; while in water samples for post-immersion of idol (P.O.P.) slightly increased by 1.3% and 1.86% respectively in comparison with the water samples for pre-immersion as shown in figure- 5 and 6; in Table-2.

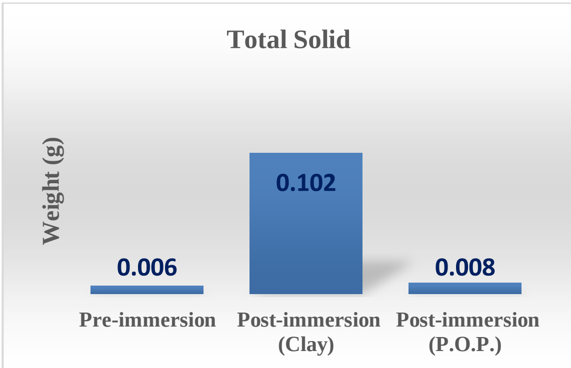

Figure 5: Graph of comparative Total Solids of water samples

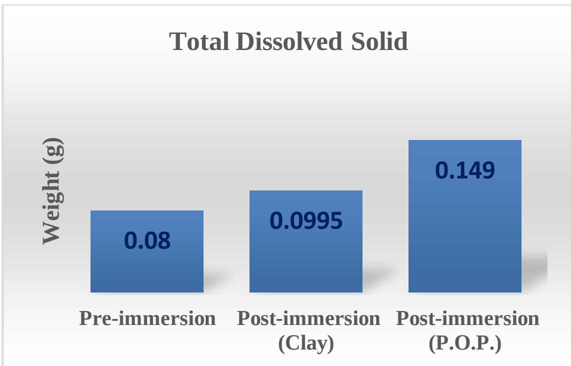

Figure 6: Graph of comparative Total Dissolved Solids of water samples

Ammonia (NH_3) Analysis by Nesslerisation Method:

From the results through the standard graph as shown in figure- 7, Ammonia (NH_3) was found to be 3.44 mg in water samples for preimmersion compared to these value no change in concentration obtained to be 3.44 mg in water sample for post-immersion of idol (Clay) while highly increased value of 7.5 mg in water sample for post-immersion of idol (Clay) as shown in figure- 8 and in Table-2. The ammonia graph analysis describes that, there is a noteworthy increase in the concentration level of ammonia in the water body, after the idol (P.O.P.) immersion. A small amount of increase in ammonia level can interrupt the stability of aquatic eco-system. Direct consumption of Ammonia (NH_3) for prolonged time may create complications in the respiratory system.

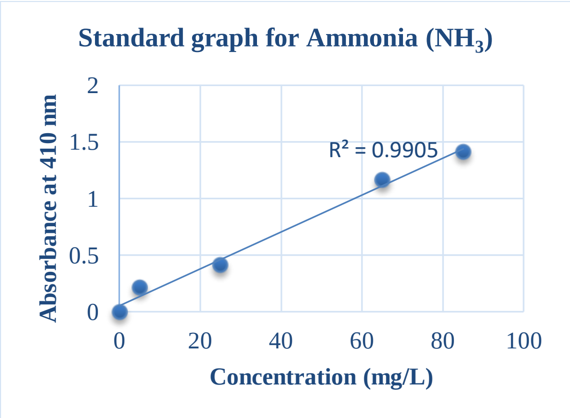

Figure: 7 Standard Graph for Ammonia (NH_3)

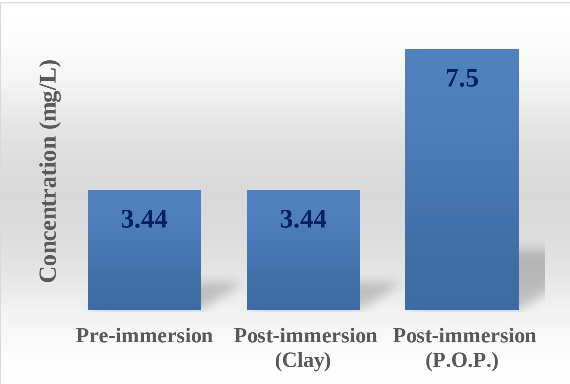

Figure: 8 Graph of comparative Ammonia content in water samples

Chlorine (Cl^-) Analysis by Argentometric Method:

From the results through the standard graph as shown in figure- 9, Chloride (Cl^-) was found to be 1.25 g in water samples for pre-immersion compared to these value slightly increased about 1.3 g in water sample for post-immersion of idol (Clay) while highly increased value of 3.1 g in water sample for post-immersion of idol (P.O.P.) as shown in figure- 10 and in Table-2. Due to these high Chloride (Cl^-) content, it may increase TDS value of water.

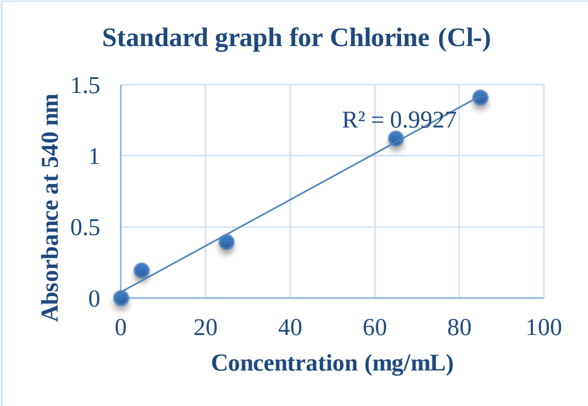

Figure: 9 Standard Graph of Chlorine (Cl^-)

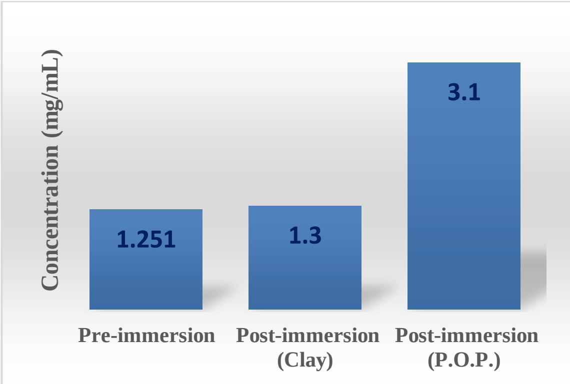

Figure: 10 Graph of comparative Chlorine content in water samples

Boron (B) Analysis by Curcumin Method:

From the results through the standard graph as shown in figure- 11, Boron (B) was found to be 83.4 mg in water samples for preimmersion compared to these value increased about 135.25 mg in water sample for post-immersion of idol (Clay) while highly increased value of 307.75 mg in water sample for post-immersion of idol (P.O.P.) as shown in figure- 12 and in Table-2. Boron at high levels (above 1 ppm) is examined to be a serious warning for the usage of water for both drinking and agriculture purpose.

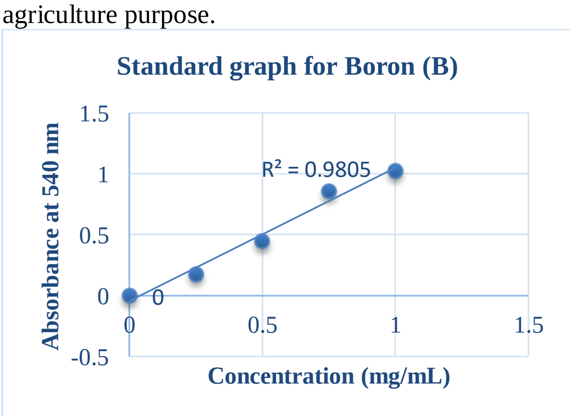

Figure: 11 Standard Graph of Boron

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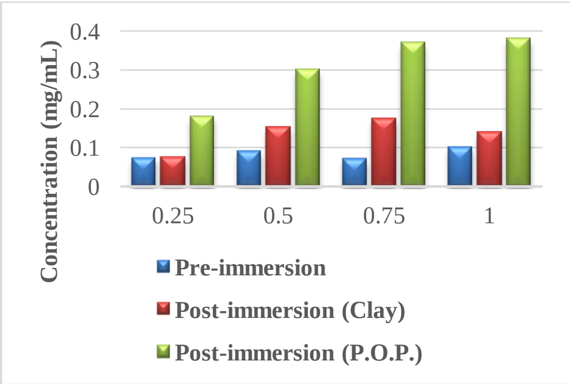

Figure: 12 Graph of comparative Boron content in water samples

Suphate (SO_4^{2-}) Analysis by Turbidimetric Method:

From the results through the standard graph as shown in figure- 13, Suphate (SO_4^{2-}) was found to be 0.849 mg in water samples for pre-immersion compared to these value increased about 2.88 mg in water sample for post-immersion of idol (Clay) while highly increased value of 9.45 mg in water sample for post-immersion of idol (P.O.P.) as shown in figure- 14 and in Table-2. Sulphate concentrations after idol immersion in water samples were increased to high folds as compared to before idol immersion.

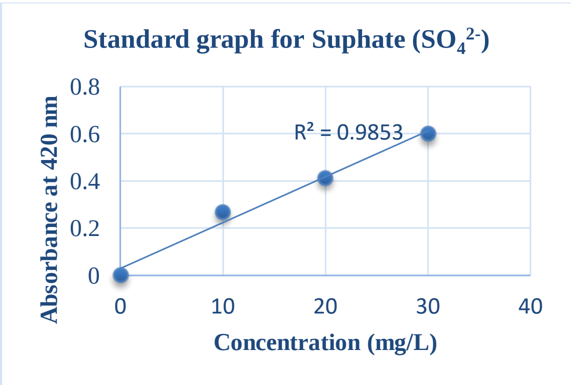

Figure: 13 Standard Graph of Sulphate

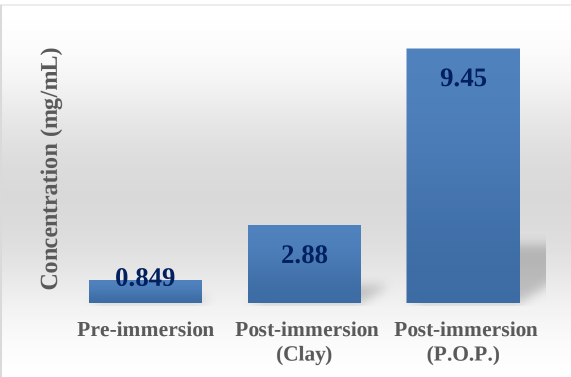

Figure: 14 Graph of comparative Sulphate in water samples

Table: 2 Result of Physio-chemical Analysis

Parameters analysed	Pre-immersion	Post-immersion (Clay) based idol	Post-immersion (P.O.P) based idol
pH	8.56	7.75	7.2
Total Solids (g)	0.006	0.102	0.008
Total Dissolved Solids (g)	0.08	0.0995	0.149
Ammonia (NH_3) (mg/L)	3.44	3.44	7.5
Chloride (Cl^-) (mg/mL)	1.25	1.3	3.1
Boron (B) (mg/mL)	83.4	135.25	307.75
Sulphate (SO_4^{2-}) (mg/mL)	0.849	2.88	9.45

Heavy metal Analysis by AAS technique:

The concentrations of heavy metals in water samples were changed from 0.2455 mg/L to 0.0773 mg/L in post-immersion of idol (Clay) and 0.2592 mg/L in post-immersion of idol (P.O.P.) for chromium; concentration of 0.0131 mg/L was obtained only in post-immersion of idol (P.O.P.) for lead; concentration changed from 0.0345 mg/L to 0.0273 mg/L in post-immersion of idol (Clay) and 0.0396 mg/L in post-immersion of idol (P.O.P.) for zinc; before and after idol immersion respectively. Concentrations of metals such as Chromium (Cr), Lead (Pb), Zinc (Zn) had increased noticeably after idol immersion into water samples as shown in figure- 15 and Table-3. Presence of heavy metals indicates that the river water became highly polluted because of the immersion activities. This is due to the chemical paints used on these idols contain heavy metals as Chromium (Cr), Lead (Pb), Zinc (Zn) and various organic and inorganic matter, leading to alteration in water quality.

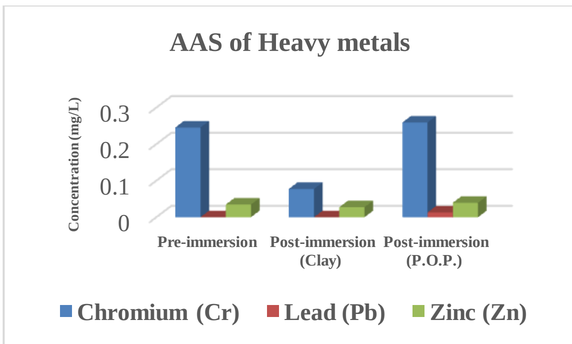

Figure: 15 Graph of comparative Heavy metal content in water samples

Table: 3 Result of AAS of Heavy metals

Parameters analysed	Pre-immersion	Post-immersion (Clay) based idol	Post-immmersion (P.O.P) based idol
Chromium (Cr) (mg/L)	0.2455	0.0773	0.2592
Lead (Pb) (mg/L)	0	0	0.0131
Zinc (Zn) (mg/L)	0.0345	0.0273	0.0396

4.Conclusion:

Idol immersion has major impact on water quality, particularly concerning heavy metals. The input of biodegradable and non-biodegradable substances deteriorates the water quality and enhances silt load in the water bodies. The floating material released through idol in the water bodies, after accumulation result in eutrophication. The present study clearly reflects the negative impact of the idol immersions in the water bodies, in particular to the use of P.O.P. based idols. In contrary, the Clay based idols are also the source of negative impacts to environment; although in lower amount than the P.O.P. based idols. So, it becomes ultimate necessary to introduce several environmental conserving steps for the idol immersions without harming the religious sentiments as well as the ancient culture of our country. Therefore, it becomes very essential to adopt several alternatives such as use of natural ornaments, bio-colors, immersion of idols in artificial ponds or idols itself made up of biodegradable materials. Now-a-days, idols made up of chocolate as well as edible components are now in trends also.

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Author's Contribution:

Jitendra Nayak (Research student) performed the research work, calculations, contributed to the writing of the manuscript and corresponding author of the manuscript. Ayush Jain (Research student) and Tanvi Tamakuwala (Teaching Assistant) performed the research work and calculations. Dr. Bhikhu More (Teaching Assistant) and Dr. Mansi Mehta (Teaching Assistant) helped in research design and data interpretation. Dr. Gaurav Shah (Assistant Professor) is the Project leader, supervised the research work and contributed to editing of the manuscript.

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