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ANALYSIS OF WATER QUALITY OF RIVER GANGA

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ABSTRACT:

This study is an attempt to analyze the water quality of river Ganga in Patna district. Water samples were collected from 4 different Ghats . Due to heavy discharge of municipal waste and anthropogenic activities in the river the biological, chemical and physical characteristics of water have changed to a considerable extent. The objectives of this study were to find out the changes in physicochemical nature as well as biological health of river Ganga. Samples were analyzed on various physicochemical parameter i.e. pH,total hardness, and total dissolved solids by using the standard methods and procedures.

INTRODUCTION :

Water is an essential natural resource in the world on which existence of life depends. From the history, it is well known fact that all the great civilization around the world evolved around the rivers . Due to growing population, unorganized urbanization and fast industrialization along the rivers, the quality and quantity of water resources declining. Water quality is defined in terms of its physicochemical and biological parameters. The major pollution source in river Ganga at Patna are untreated domestic sewage waste water, industrial effluents and dead bodies. Today over 29 cities, 70 towns and thousands of villages extend along the Ganga banks. All of their sewage over 1.3 billion liters per day goes directly to the river . The present investigation was carried out along 4 different Ghats of River Ganga in Patna district .Under this investigation physicochemical quality of Ganga water i.e. pH, total dissolved solids, and Total hardness were determined by using standard protocols.The bacteriological examination of water has a special significance for pollution studies as it is a direct measurement of effects of pollution on human health. Total coliforms are indicator organism of fecal contamination in water . Microbial analysis was performed in terms of most probable number. Presences of fecal coliform were seen in all sample of Ganga water obtained from 4 different Ghats in Patna district.

MATERIALS AND METHODS :

This study was conducted between jan to jun in Patna district, India. In the present investigation water sample were collected from 4 different Ghats of river Ganga in Patna district, Bihar state, India. Analysis of physicochemical biological properties of water samplesDetermination of Physicochemical properties Determination of pH: pH indicates acid base balance of water and mainly depends upon carbonic acid and interaction between carbonates and bicarbonates. The pH value was determined by using digital pH meter .

Determination of Total dissolved solids (TDS)

Salts like carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc. are dissolved in natural water. Total dissolved solids (TDS) refer to any minerals, salts, metals, cations or anions dissolved in water. The high content of dissolved solids increases the density of water. The TDS values varied from 21±2 mg/l to 36±0.23 mg/l in station I. Its highest value was observed in the month of June

(90±6.8 mg/l) in station II . Fresh water contains various kinds of inorganic minerals as well as some organic materials in dissolved state. Higher concentration of these substances causes pollution. Dissolved solids do not contain gas and colloids. In drinking water it is an important parameter which gives particular test to water. Statistical analysis by Two way ANOVA on TDS of water as a function of variation between stations are statistically significant ($F= 15.85$; $p<0.05$). In natural water dissolved solids are mainly minerals . In drinking water it is exclusively important parameter which gives particular test to water. Water with a high total dissolved solids indicated more ionic concentration. Kataria reported that increase in value of TDS indicated pollution by extraneous sources.

Determination ofTotal hardness

In the present study water samples of different locations was observed in the range of 7±1.3 mg/l to 44 ±1.3 mg/l. The maximum total hardness was observed as 12±0.7 mg/l, 48±3.3 mg/l, 32±1.6 mg/l and 31±1.3 mg/l, respectively in station I, II, III and IV. The result indicated that this water is highly suitable for drinking purpose. The total hardness of water samples from station I to station IV is described in individual figures. Statistical analysis by Two way ANOVA on total hardness of water as a function of variation between stations are statistically significant ($F= 8.277$; $p<0.05$). The hardness of water is not a pollution parameter but indicates water quality. Although hard water has no effect on health but it is unsuitable for domestic use.

Hardness is mainly due to presence of divalent cations like Ca^{++}, Mg^{++}, Sr^{++}, Fe^{++} and Mn^{++} which may be present in the combination with various anions like HCO_3^-, SO_4^{--}, Cl^-, NO_3^-, SiO_3^- etc . Hardness of water is a measure of its capacity to produce lather with soap . According to some classification, water having hardness upto 75 mg/l is classified as soft, 76-150 mg/l is moderately soft, 151-300 mg/l as hard and more than 300 mg/l as very hard . Based on the present finding, the water sample collected was considered as soft water because of low hardness.

Summary of the data set:

Source: www.bspcb.bih.nic.in

Data structure:

The present study deals with the physicochemical and microbial analysis of Ganga Water collected from 4 Ghats of Patna region, Bihar, India. The collected water samples were analyzed for their physicochemical properties like: pH, total dissolved solids and Total hardness. The values are enlisted in Table 1,2,3 respectively.

Table no 1: pH of 4 different sampling sites during different date of observations

Serial no	Sampling sites	Date of observation					
		jan	feb	mar	apr	may	Jun
1	LCT ghat	6.2	6.3	6.2	6.3	6.3	6.3
2	Digha ghat	6.4	6.4	6.3	6.4	6.8	6.7
3	Kali ghat	7.1	7.0	7.2	7.0	7.2	7.1
4	Dheere ghat	6.8	6.8	6.8	6.9	6.7	7.0

Table no 2: TDS of 4 different sampling sites during different date of observation

Serial no	Sampling sites	Date of observation					
		jan	feb	mar	apr	may	jun
1	LCT ghat	25	27	25	25	30	26
2	Digha ghat	26	27	27	28	32	30
3	Kali ghat	44	46	46	42	48	45
4	Dheere ghart	48	50	48	56	60	54

Table no 3: total hardness of different sampling sites during different date of observation

Serial no	Sampling sites	Date of observation					
		jan	feb	mar	apr	may	Jun
1	LCT ghat	10.4	9.5	8.7	10.9	11.1	9.1
2	Digha ghat	9.8	10	9.6	44.6	42.4	10.2
3	Kali ghat	20.1	18.6	20.5	20.2	22.2	21.4
4	Dheere ghat	22.4	20.7	20.6	21.6	20.7	21.2

Fig 1: Histogram for pH of different sampling sites during the date of observation

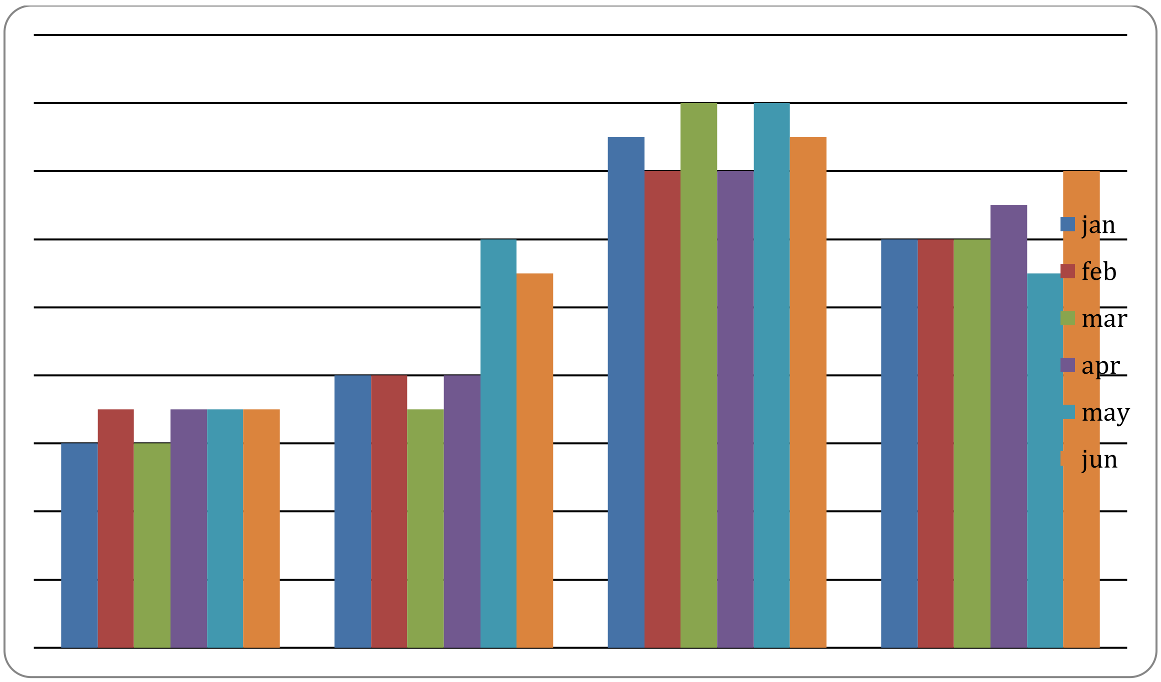


Fig 2: Histogram for TDS of different sampling sites during the date of observation

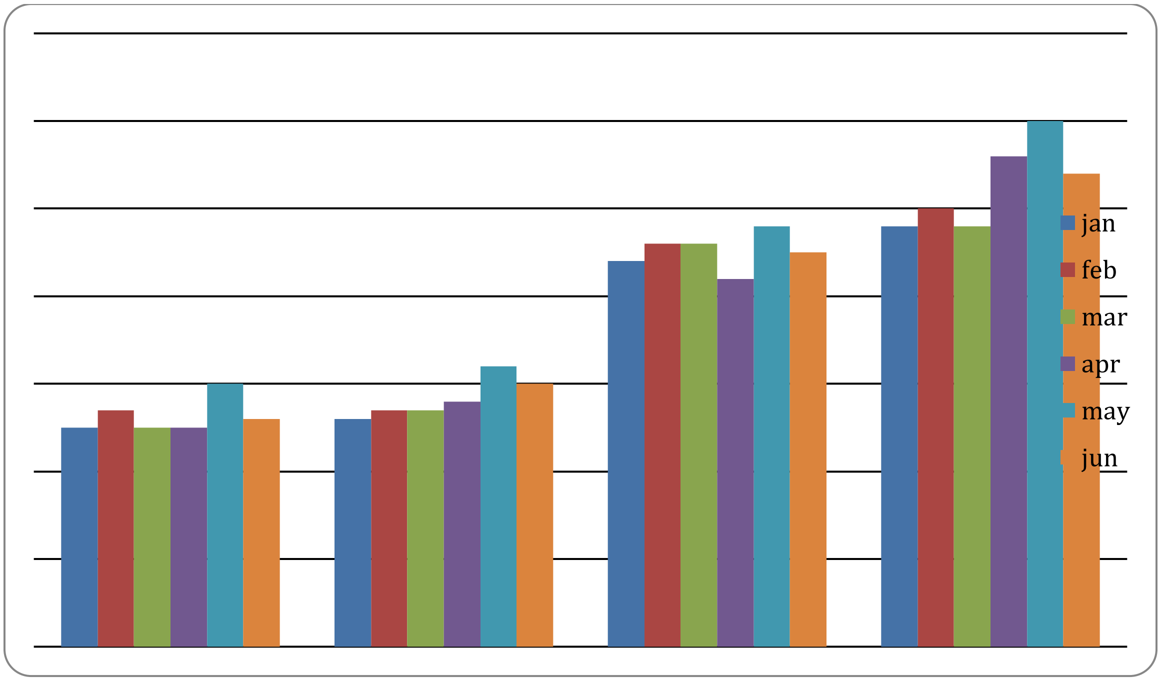
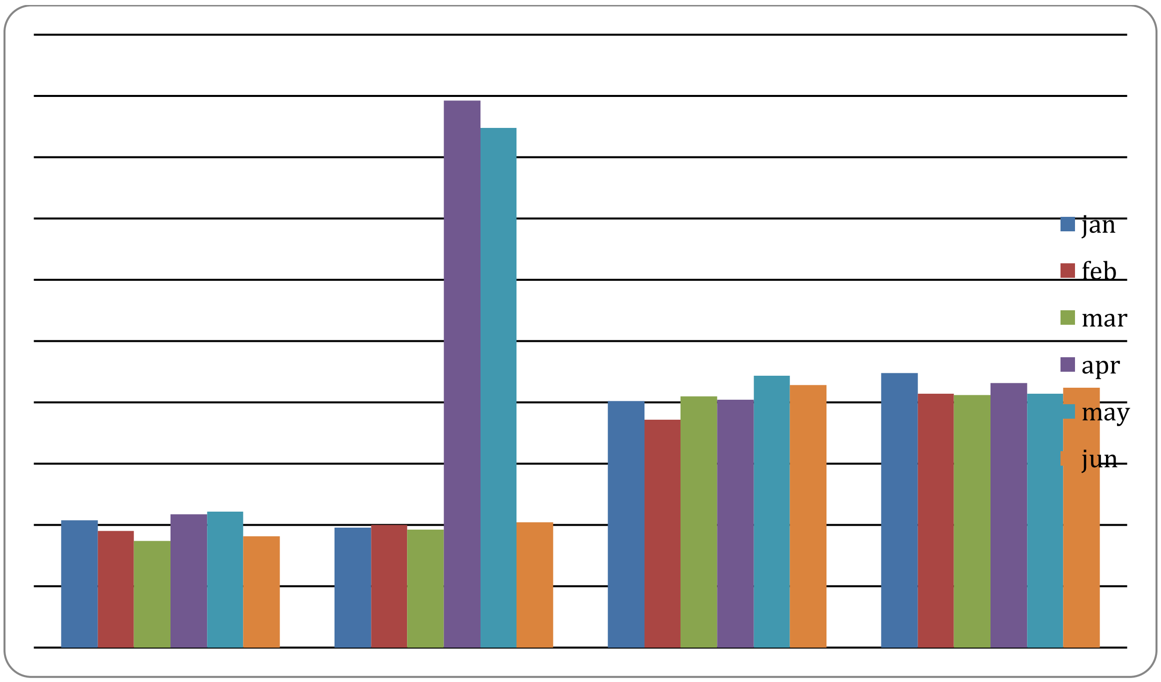


Fig 3: Histogram for Total hardness of different sampling sites during the date of observation



- **ANOVA Model**:

For the given data we use two-way fixed effect Analysis of variance model.

The underlying model is given by,

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$$

$$and\ \ \varepsilon_{ij} \sim N(0, \sigma^2) \qquad for\ i = 1(1)n\ , j = 1(1)k$$

Where,

Y_{ij}: effect due to i^{th}sampling site in the j^{th}physicochemical material

μ: general effect

α_i: additional effect due to i^{th}smapling sites

β_j: additional effect due to physicochemical material

With assumption ,

$\sum_{i=1}^{n} \quad \alpha_i$=0 and $\sum_{i=1}^{k} \quad \beta_j = 0$

- **Hypothesis**:

Here we want to test whether sampling sites are not same or not that is we want to test,

$H_0: \alpha_1 = \alpha_2 = \cdots = \alpha_n = 0$ against H_1: not H_0

Orthogonal splitting:

The total variation is partitioned as,

TSS=SSA +SSB+SSE

Where,

TSS is the total sum of variation,

SSA is the sum of squares due to sampling sites,

SSB is the total sum if squares due to different physicochemical metarials and

SSE is the sum of squares due to error.

TSS=$\sum_{i=1}^{n} \sum_{j=1}^{k} \left(y_{ij} - y_{0\bar{\bar{0}}}\right)^2$

SSA=k$\sum_{i=1}^{n} (y_{i0} - y_{0\bar{\bar{0}}})^2$

SSB=n$\sum_{j=1}^{k} \left(y_{0j} - y_{0\bar{\bar{0}}}\right)^2$

SSE=$\sum_{i=1}^{k} \sum_{j=1}^{n} \left(y_{ij} - \underline{y_{i0}} - \underline{y_{j0}} + y_{0\bar{\bar{0}}}\right)^2$

Under, H_0, $\frac{SSA}{\sigma^2} \sim x_{n-1}^2$

And $\frac{SSE}{\sigma^2} \sim x_{(k-1)*(n-1)}^2$ independently

• Statistic:

That stasistic is obtained from the ratio

F_1**= MSA/MSE** F_2**=MSB/MSE**

MSA=$\frac{SSA}{(n-1)}$ And MSE=$\frac{SSE}{(k-1)(n-1)}$

MSB=$\frac{SSB}{(k-1)}$

Hence ,under H_0,

$$F=\frac{MSA}{MSE} \sim F_{(n-1),(n-1)(k-1)}$$

We reject H_0 at level α if,

$$F_{obs} > F_{\alpha;(n-1),(n-1)(k-1)}$$

$$F_{obs} > F_{\alpha;(k-1),(n-1)(k-1)}$$

Calculation:

ANOVA table for pH of different sampling sites during date of observation

Source of variation	df	SS	MS	F_{obs}	F at level	
					.01	.05
Variation between samplimg sites	3	2.418	0.806	57.571	5.42	3.29
Variation between dates	5	0.095	0.019	1.3571		
Error	15	0.212	0.014			
total	23					

As the observed value F_{obs} is greater than F at 5% and 1% level .Thus we reject our null hypothesis at both 5% and 1% level of signification.

ANOVA table for TDS of different sampling sites during date of observation

Source of variation	df	SS	MS	Fobs	F at level	
					.01	.05
Variation between samplimg sites	3	2975.791	991.9303	214.212	5.42	3.29
Variation between dates	5	113.375	22.675	4.8967		
Error	15	69.459	4.6306			
total	23					

As the observed value F_{obs} is greater than F at 5% and 1% level .Thus we reject our null hypothesis at both 5% and 1% level of signification.

ANOVA table for total hardness of different sampling sites during date of observation

Source of variation	**df**	**SS**	MS	F_{obs}	F at level	
					.01	.05
Variation between samplimg sites	3	544.5713	136.143	1.883	5.42	3.29
Variation between dates	5	438.3938	87.678	1.2127		
Error	15	1084.4412	72.296			
total	23					

As the observed value F_{obs} is greater than F at 5% and 1% level .

Thus we accept our null hypothesis at both 5% and 1% level of signification.

CONCLUSIONS:

From this study, the results clearly indicate that the water quality of the river Ganga is contaminated. The water quality declined mainly due to mass bathing, discharge of untreated sewage water, domestic waste water of Patna urban area. Establishment of the large number of apartments, industries, and hospitals on the bank of river Ganga has led to increasing the pollution. There is urgent need of taking some appropriate measurement to stop further deterioration of Ganga river water quality.Awareness is needed among the people of concerned areas to decrease the level of pollution in Ganga water, a collective approach by the Government, common people,media, students, and all the section of the society is essential.

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