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Studies on Faecal Pollution of Yamuna River at Agra

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Eight different forms of bacteria viz., *Staphylococcus aureus, Shigella sp., Klebsiella sp., Escherichia coli, Aerobacter aerogenes, Salmonella paratyphi, Proteus Vulgaris, Pseudomonas aureoginosa,* were isolated which showed variable percentage of abundance. *Escherichia* and *Aerobacter aerogenes* were most abundant during the period of this study. All the species of bacteria—isolated except *Staphylococcus aureus* were gram negative (-ve) and belonged to coliform group which showed very high degree of faecal pollution.

Key Words : Faecal, gram negative (−ve) gram positive (+ve) coliform

Introduction

The contamination of water resources by the discharge of faecal matter from cities and towns located along their banks is a common phenomenon. It renders water not only unsafe but also unhygienic for public use due to the presence of sufficient number of coliform organisms and other pathogenic bacteria like *Salmonella typhi, Salmonella paratyphi, Shigella dysentriae Klebsiella sp.* and *Vibrio cholerae* etc. which are associated with serious human diseases. Therefore, the presence of these bacteria assumed much importance in the public health. Keeping it in view, it was desired to conduct this study in order to assess the degree of faecal pollution of this important river at Agra.

The samples were collected with regular intervals from Jal Sansthan, intake following APHA (1975). The isolation and culture of specific bacteria was made according to Sirockin and Cullimore (1969) and Ferlin and Carbinos (1954) on differential media. The confirmation and identification of specific bacteria was made by physiological test (IMVI-C) (table 2). The abundance of each vacteria was calculated with the help of following formula.

$$\% \text{ abundance} = \frac{\text{No. of Colonies of particular bacteria} \times 100}{\text{(total no. of colonies)}}$$

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Table 1 *Bacteriological analysis for specific bacteria in river Yamuna (Nov. 1979–Oct. 1981) Values in % abundance*

Season & Month	Year	Bacteria									
		Staphylo-coccus aureus	*Shigella* sp.	*Klebsiella* sp.	*Escheri-chia coli*	*Aerobac-ter aerogenes*	*Salmo-nella paratyphi*	*Proteus vulgaris*	*Pseudo-monas aureo-ginosa*	*Strepto-coccus pyogens*	Other (Un-identi-fied)
WINTER											
Nov.	1979-80	0.04	—	—	44.82	48.35	—	1.35	1.35	—	—
	1980-81	0.05	—	—	48.11	44.43	—	1.73	1.73	—	—
Dec.	1979-80	0.05	—	—	40.44	52.35	—	—	1.84	—	—
	1980-81	0.08	—	—	40.71	45.53	—	—	1.02	—	—
Jan.	1979-80	0.09	—	—	39.04	52.65	0.08	—	2.86	—	—
	1980-81	0.07	—	—	38.24	53.99	0.14	—	2.47	—	—
Feb.	1979-80	0.07	—	—	48.42	42.34	0.15	—	3.14	—	—
	1980-81	0.08	—	—	53.36	45.79	0.25	—	3.63	—	—
SUMMER											
Mar.	1979-80	0.04	—	—	41.75	51.13	0.18	—	2.80	—	—
	1980-81	0.04	—	—	47.80	44.54	0.17	—	3.17	—	0.09
Apr.	1979-80	0.05	—	0.01	46.88	47.40	0.08	—	1.62	—	0.07
	1980-81	0.07	—	0.02	46.29	47.00	0.04	—	2.44	—	0.08
May.	1979-80	0.08	0.01	0.01	44.53	48.85	—	—	2.23	—	0.07
	1980-81	0.08	—	0.01	49.85	43.15	0.03	—	2.61	—	0.05
Jun.	1979-80	0.08	—	0.02	47.22	46.45	0.03	—	2.47	—	0.05
	1980-81	0.08	0.01	0.02	50.93	42.35	0.05	—	2.56	—	0.07
RAINS											
Jul.	1979-80	0.06	—	—	57.54	33.75	0.08	—	3.53	—	0.06
	1980-81	0.06	—	0.01	56.34	34.05	0.08	—	3.40	—	0.09
Aug.	1979-80	0.08	—	—	54.70	32.56	—	—	2.06	—	0.19
	1980-81	0.06	—	—	59.17	32.28	—	—	2.26	—	0.12
Sep.	1979-80	0.07	—	—	38.63	38.63	—	—	2.11	—	—
	1980-81	0.06	—	—	54.82	36.54	—	—	2.32	—	—
Oct.	1979-80	0.05	—	—	47.59	45.47	—	—	0.93	—	—
	1980-81	0.06	—	—	48.45	46.28	—	—	1.70	—	—

Table 2

Bacteria	Specific colony on differential media	Physiological Tests						
		Gram stain	Indole	Methyl red	V.P.	Hydrogen sulphide	Nitrate reductase	Oxidase
Staphylococous aureus	Colony smooth, circular on Nutrient agar, first white and then turn golden.	+ve	−	−	−	+	+	+
Shigella sp.	Small translucent colourless colonies on EMB.	−ve	−	−	−	+	+	+
Klebsiella sp.	Colony on EMB pinkish mucoid with small dark-brown centers or without.	−ve	±	+	−	+	+	−
Escherichia coli	Colony on EMB large with large dark (almost black) centers, and with greenish metalic sheen.	−ve	−	+	−	−	+	−
Aerobacter aerogenes	Large pinkish mucoid colonies with small dark-brown or black centers, some times show metalic sheen on EMB.	−ve	−	−	+	−	+	−
Salmonella paratyphi	Translucent, colourless or Pinkish colonies on EMB in later stages of incubation gives bluish tint.	−ve	−	−	−	−	+	−
Proteus vulgaris	Colonies on EMB colourless and spreading on medium surface and become grey in colour.	−ve	+	−	−	+	+	−
Pseudomonas aureoginosa	Small translucent colonies on EMB colourless and in advancement of incubation becomes creamy in colour.	−ve	±	−	−	+	+	−
Streptococcus pyogens	Colonies on Nutrient agar small, discrete, translucent, convex with entire edge.	−ve	−	−	−	−	−	+

V. P. Vogee-Prokauer test

Results and Discussion

The observations made from 1979–Oct. 1981 are given in the table 1. In all eight bacterial forms viz. *Staphylococcus aureus, Shigella sp. Klebsiella sp., Escherichia coli, Aerobacter aerogenes, Salmonella paratyphi, Proteus vulgaris, Pseudomonas aurcoginosa,* could be identified. In addition some unidentified forms were also recorded. They were artificially grouped into three categories i.e., (*i*) Most abundant (10% and above), (*ii*) Abundant (1–10%) and (*iii*) Less abundant (below 1%).

The recorded speices of bacteria did not show any definite pattern with respect to percentage abundance but found variable in different months and seasons. The species viz., *E. coli* and *A. aerogenes* were recorded most abundant whereas *Pseudomonas aureoginosa* and *Proteus vulgaris* were abundant. *Staphylococcus aureus, Shigella sp., Klebsiella sp.,* and *Salmonella paratyphi* were recorded less abundant during the course of this study. The results further indicate that *Shigella sp.,* and *Proteus vulgaris* were observed only in summer and winter respectively. The abundance of these bacterial forms was probably due to the organic matter present in the river (table 3). Moreover, the seasonal variations in temperature, and river flow were other important factors which influence the percentage abundance of these forms up to a certain extent (table 3). The investigations of Wang et al. (1959), Smith (1970) and Ezura et al. (1974) are in full accordance with the present investigation.

Table 3 *Physico-chemical characteristics of river Yamuna for the year 1979-80 & 1980-81*

Sl. No.	Physico-chemical Characteristics	1979-80			1980-81		
		Winter	Summer	Rain	Winter	Summer	Rain
1.	Colour	S. yellowish	yellowish	Mudy	S. reddish	S. yellowish	Mudy
2.	Odour	NS	SOS	NS	NS	NS	NS
3.	Temperature°C	18.15	33.825	35.725	17.05	32.875	32.80
4.	Turbidity	40.50	54.75	602.00	50.75	28.75	618.75
5.	*p*H	8.35	8.025	8.00	8.225	8.575	8.70
6.	Total solids	626.00	675.25	822.50	727.50	515.00	890.00
7.	Suspended solids	173.50	109.25	237.50	192.50	170.00	535.00
8.	Dissolved solids	452.50	566.00	585.00	535.00	345.00	380.00
9.	River flow Ft/sec.	0.103	0.040	4.289	0.191	0.107	3.419
10.	DO	10.725	5.55	6.45	11.90	8.05	7.03
11.	BOD	35.50	117.00	154.50	22.50	33.50	20.00
12.	COD	292.00	512.50	452.50	422.50	694.00	345.00
13.	Ammonia	0.209	0.273	0.067	0.164	0.219	0.038
14.	Organic Nitrogen	0.394	0.499	0.205	0.2525	0.5525	0.470
15.	Phenols	0.0005	0.002	0.00	0.0011	0.0025	0.0301

All values except temperature, *p*H and river flow are in mg/l
BOD: Biochemical Oxygen Demand; *COD*: Chemical Oxygen Demand; *DO*: Dissolved Oxygen; *NS*: No smell; *SOS*: Slight organic smell

It was obvious in the present study that most of the isolates belonged to gram negative (−ve) group except *Staphylococcus aureus* which was gram positive (+ve) and the results were in good agreement with the work of Shimidu and Aiso (1962) and Niewolk (1973) who reported almost similar results.

The studies clearly revealed that the presence of coliform group of bacteria indicated fairly high degree of faecal pollution in the river water. On the basis of these studies it was concluded that the bacteriological quality of river water was much inferior as against the Indian as well as International standards and was unacceptable for recreational and drinking purpses without proper chemical treatment.

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