

Total Phenols as Pollution Indicator of Sewage and Sewage Contaminated Canal

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Summary: Total phenol concentration was examined in Hyderabad city sewage, before and after addition of sewage to Fuleli canal and river Indus. Total phenol was observed within the ranges 0.23-2.5 mg/L in sewage, below detection limits to 0.95 mg/L at Fuleli canal and below detection limit to 0.08mg/L at river Indus at Kotri barrage. The variation of phenol contents with water discharge and seasons at river Indus and Fuleli canal were also investigated and inverse relation of concentration of phenol with water discharge was observed. The concentration of phenols in sewage and Fuleli canal exceeded the permissible limits for sewage and surface water respectively.

Introduction

Phenols are found in nature in the form of anthocyanines, coaltar and flavolan and may be responsible for color of many flowers and fruits [1].

Some phenols are used in drugs as antiseptic, detergents, dyes and disinfectants, but they are generally toxic and may damage urinogenital organs, liver and kidneys [2]. The pollution of the aquatic environment from phenols may be natural or under the stress of human activity due to the input from domestic waste water and industrial effluents [3].

A number of analytical procedure are reported for the determination of phenols, mainly based on spectrophotometric [4-8], fluorimetric [9], kinetic [10], gas chromatographic [12], liquid chromatographic [13-15] and enzyme and biosensors [16-20].

A few reports are available on the water quality of river Indus and Fuleli canal [21-27], but the work examines total phenols as pollution indicator of sewage and sewage contaminated canal. The spectrophotometric method involving 4-aminoantipyrine is a standard method for the determination of total phenol [8] and was used for monitoring of total phenols in river Indus, city sewage and Fuleli canal.

Results and Discussion

a) River Indus at Kotri Barrage

The monitoring of phenolic compounds in surface water is important due to their toxicity and

possible bioaccumulation. The mean concentration of phenols at river Indus was observed 32 µg/L (n=13) with a range below the detection limit to 81 µg/L. The phenols registered their peak values in the months of lowest water discharge in Dec. and Jan., which may be attributed to the fact that water in these months was stagnant and favoured the formation of algae, which on disintegration could probably add phenolic material in water [28]. The lowest concentration of phenols was observed during July to September with highest water discharge in river Indus.

b) Sewage Water

Total phenolic compounds detected were at a significantly high level in the waste water. The highest mean value of 1.62 mg/L was recorded at sampling station II, while lowest mean value of 0.61 mg/L of phenol was found at station I and indicated parallel trend as observed for chemical oxygen demand (COD) [27].

The concentration of phenols from all the sewage sampling sites varied between 0.23-2.5 mg/L, which is higher in magnitude by several orders than the recommended values by NEQS (National Environmental) Quality Standards, Govt. of Pakistan [29].

c) Fuleli canal Water

Fuleli canal indicated lowest mean concentration of 28 µg/L at sampling station 2 which did not receive any polluting sewage water. The maximum average of 0.25 mg/L and 0.23 mg/L of phenols at

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Table-I: Quantitative values of total phenols river Indus and Fuleli canal (n=13)

Value of Phenols (mg/L)	Sampling Stations							
	1	2	3	4	5	6	7	8
Mean X	0.032	0.028	0.12	0.23	0.25	0.20	0.16	0.14
Extreme (Range)	H.D-0.81	H.D-0.06	0.02-0.36	0.065-0.54	0.04-0.95	0.07-0.65	0.041-0.57	0.31-0.45

N.D=Not Detected

Table-II: Quantitative analysis of total phenols at different sewage station before entering in Fuleli canal

Value of Phenols (mg/L)	Sampling Stations				
	I	II	III	IV	V
Mean (n=13) X	0.061	1.62	1.48	0.76	1.31
Extra (Range)	0.23-1.12	0.07-2.47	0.82-2.24	0.30-1.35	0.37-2.5

station 4 and 5 respectively were observed, because substantial concentration of phenolic compounds were received from adjoining sewage station, originating from densely populated area of the city where cottage industries are located and work of dyes, detergents and soap formations are the principal sources for elevating the phenolic concentrations. The concentration of phenols at sampling stations 3, 6, 7 and 8 were higher by factors of 4.3, 7.0, 5.7 and 5.0 respectively than the station 2, and reflect the significant stress of untreated or partially treated sewage water entering the canal. The concentration of phenols along the canal varied within the range below the detection limit to 0.95 mg/L. The upper limit was higher by order of several magnitude than the recommended surface water quality standards for phenols [30] which could be threat to aquatic life of canal. Seasonal variability in phenolic compounds along Fuleli canal was investigated and an inverse correlation of phenols with discharge was observed at sampling station 3 to 8. The highest concentration of phenols were recorded in Dec. and Jan. due to very low dilution of sewage with canal water. However during high water discharge during July and August with high dilution factor the concentration of phenols in canal reduced considerably.

Experimental

Fuleli canal takes off from river Indus from eastern side of Kotri barrage. It receives sewage and industrial effluents while it passes a distance of about 25 km from Hyderabad city with a population of about 1.5 million. The description about river Indus (Kotri barrage) Fuleli canal and sewage of Hyderabad city is described [22-27].

Thirteen sampling stations were selected and fixed from river Indus (one), Fuleli canal (seven) and sewage (five). A sample from river Indus was collected about 300 m above Kotri barrage and one from Fuleli canal near Akhund Village before entry of any sewage water. Four samples were collected from canal near (3) C.I.A. Centre (4) Sakhi Pir road, Lquat Colony (5) Bhatti village, Fateh Textile Mills and (6) village Darya Khan Panhwar in between the entry points sources of sewerage lines- Two samples from the canal were collected (7) after Zeal Pak Cement Factory, near village Pono Kolhi and (8) Hosri Bridge near Behar Colony, where the canal leaves city limits. Five samples from sewage lines were collected from (I) Cantonment Board waste pumping station (II) Kali Mori open sewage lines (III) open sewage lines near old power house (IV), Darya Khan pumping station and (V) Site area pumping station before draining into the canal (Fig. 1). Composite and grab sampling schemes were used for collection of samples [31, 32] at an interval of 6-8 week during 1995-1997. The sampling scheme was repeated thirteen times (n=13). The copper(II) sulphate (1 g) was added in sample (1 L) and acidified to pH 3-4 with phosphoric acid.

Analytical Procedure

Sample (250 ml) was transferred to distillation flask and was distilled, when major portion of the sample had distilled (about 200 ml), 50 ml of phenol free water was added and distillation was continued. The distillation of about 250 ml collected was transferred to separating funnel and added 10 ml of ammonium chloride sodium tartrate buffer pH 10, 4-amino antipyrine (3 ml, 2% w/v) and potassium ferri

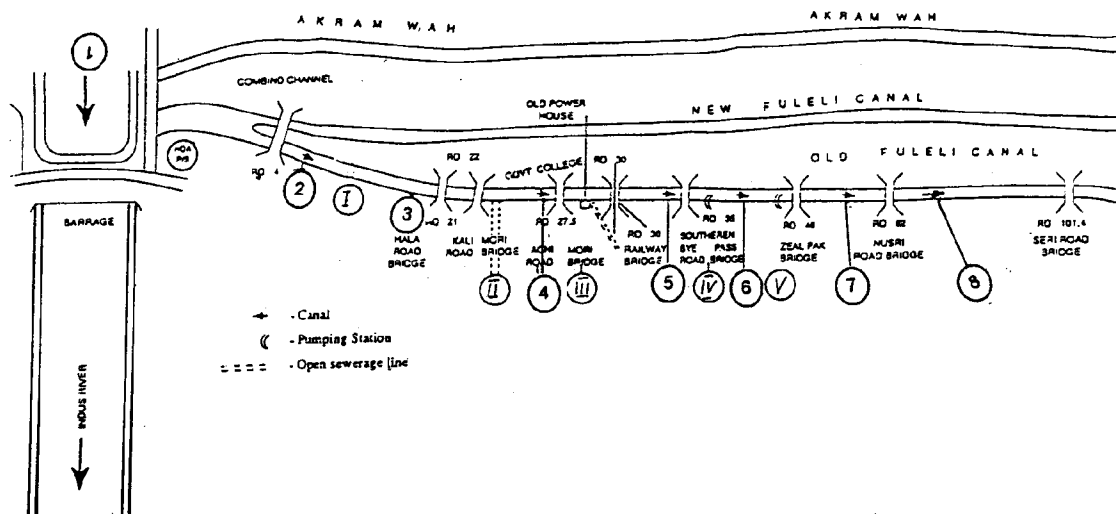


Fig. 1: Diagram of river Indus and Fuleli canal indicating the sampling stations.

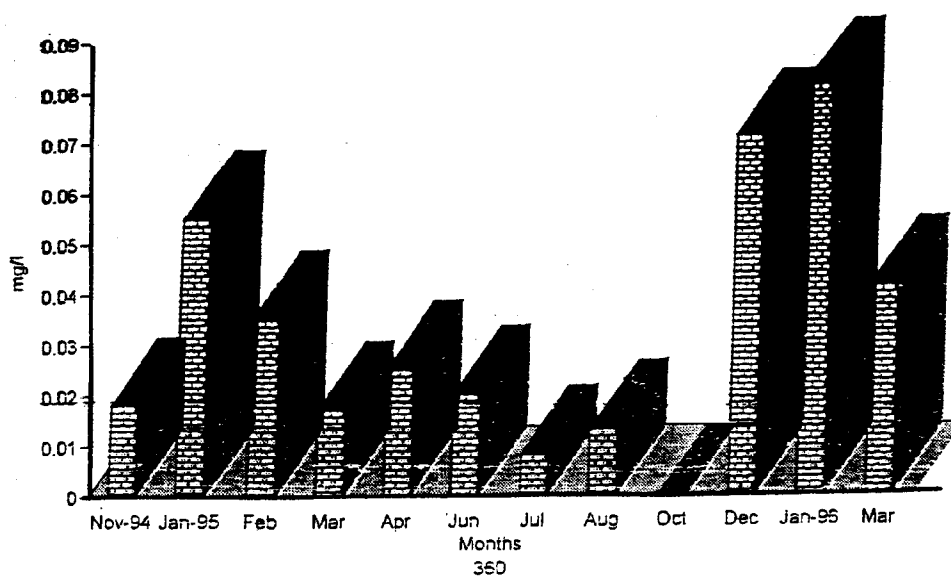


Fig. 2: Monthly variations in the concentration of phenols at river Indus at Katri barrage.

cyanide (3 ml, 8% w/v). The contents were mixed thoroughly. Chloroform (15 ml) was then added after 3 min and contents were mixed well. The layers were allowed to separate and organic layer was collected in 25 ml volumetric flask containing 1 g anhydrous sodium sulphate. The extraction was repeated with chloroform (10 ml) and final volume was adjusted

with chloroform. The solution was filtered before measurement of absorbance at 460 nm. The calibration curve was constructed by adding standard solution of phenol to 250 ml of water and following the above procedure. The reagent blank was also prepared with 250 ml of distilled water following the above procedure.

The spectrophotometric studies were carried out with Hitachi 220 spectrophotometer pH measurements were made with Orion 420 A pH meter- 4-Aminoantipyrine (Fluka), potassium ferricyanide (E. Merck), Potassium sodium tartrate (E-Merck) and phenol (E. Merck) were used.

Conclusions

The total phenols concentration in sewage was high in the range of 0.23-2.5 mg/L, which elevated the concentration of phenols due to addition in Fuleli canal upto maximum average of 0.25 mg/L, as compared to 32 ug/L at river Indus. The work indicates the correlation of total phenols as one of the water pollution indicator.

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