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Bacterial load and drug resistance in sewage from industrially polluted regions of South Gujarat region

Aneree Desai[a] and Srivathsa Nallanchakravarthula[*]

C. G. Bhakta Institute of Biotechnology, Uka Tarsadia University, Gopal vidya nagar, Tarsadi, Bardoli-Mahuva road, Surat (Dist), Gujarat, India

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Abstract. Wastewater of anthropogenic origin is known to harbor various bacteria that are known to be of potential risk to human health and environment. It is of utmost importance to monitor such water sources. Coliforms present in the sewage water samples of municipal sewage treatment plants located at three different places in the South Gujarat region (Surat, Navsari and Vapi) of India were analyzed for their coliforms load as well as tested for their drug resistance. Using cultivation-based techniques microbial load and drug resistance (Amoxicillin, Tetracycline, Ciprofloxacin, Erythromycin, Trimethoprim and Sulphamethoxazole) were analyzed. Water treatment statistically significantly decreased the bacterial load in Vapi and Navsari samples. The optical density of with and without antibiotics of all the three locations was shown to increase significantly after 72 hours. Of all the isolates tested, except isolate 'VA5' (resisted up to 90 μg of Ampicillin) all other isolates resisted 256 μg concentration of antibiotics tested. This study indicates that the sewage water is being contaminated with drugs and/or antibiotics due to industrial and/or anthropogenic activities. Regular monitoring of the water quality is required followed by implementation of environmental laws for reducing the pollutants, that are of human health and environment concern.

Keywords: antibiotics; coliforms; MDR; sewage treatment

1. Introduction

Rapid industrialization and urbanization are making water sources contaminated chemically and biologically. Due to such contaminated water, there were many outbreaks of diseases around the world (Stevens *et al*. 2003). Since last few decades, indiscriminate usage of antibiotics for human, animal husbandry and agricultural purposes led widespread emergence of multi-drug resistance (MDR) bacteria (Kardos 2017, Manyi-Loh *et al.* 2018). These changes instigated a major therapeutic challenge to understand their ecology and drug resistance mechanisms (Arias and Murray 2009). Eutrophication of rivers and overuse of antibiotics facilitate growth and survival of MDR bacteria (Verma and Rawat 2014, Klein *et al*. 2018, Singh *et al.* 2019). Such bacteria and their resistance genes were identified from various sources (drinking sources, hospitals, and other environments) including the fresh water (Schwartz *et al.* 2003, Nazaret and

*Corresponding author, Assistant Professor, E-mail: Srivathsa.nallan@gmail.com
[a]Ph.D. Student

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Table S1 Amount of Heavy metals present in the Sewage water of effluent estimated by ICP-AES, IIT Mumbai, India

No	Sample location	Ag (ppm)	Cu (ppm)	Fe (ppm)	Ni (ppm)
1	Surat	75.194	1148.6	1079.8	328.66
2	Vapi	237.83	1147.3	807.41	> 1974.61
3	Navsari	0.242	1168.7	407.65	991.52

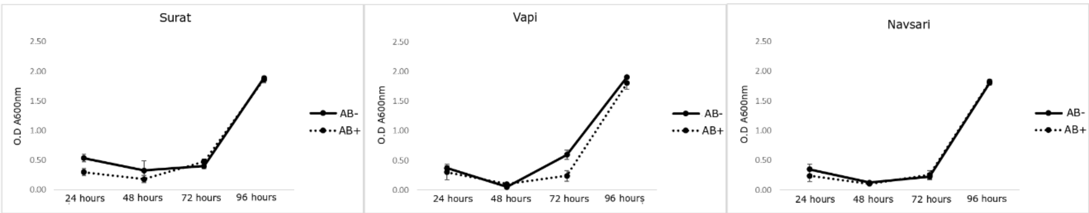

Fig. S1 Optical densities (A600) along the time scale, as observed in presence of antibiotics (+AB) and in absence of antibiotics (-AB) in the samples from Surat, Vapi and Navsari of influent sample