

Preliminary study on Narmada river water pollution; reasons and countermeasures



Pharma

KEYWORDS: Narmada river, Khandari nallah, Enteric bacteria, Anthropological activity

Poornima Sharma

Researcher, ShriRam Institute of Pharmacy, near ITI, Madhotal, Jabalpur, M.P., India

ABSTRACT

A general survey of Gwari ghat (Narmada river bank) at Jabalpur was performed and people worshipping at the ghat along with local residents were consulted regarding their beliefs on river Narmada. The level of sanitation at the bank was also observed. While there were several concerns regarding the cleanliness of ghat, most of the residents and pilgrims showed faith in the purity of river and revered her as Goddess. Although, residents directly use the water for domestic purposes, some residents also showed apprehension on lowered quality of river water due to uncontrolled anthropological activities. Several streams and small drains carrying loads of sewage from city mingle with the river. One such stream, Khandari nallah was surveyed. The water samples collected by present researcher from littoral water at the banks of river and from Khandari nallah were put under preliminary test to detect presence of enteric bacteria. High density of Coliforms were obtained on media along with some other bacteria, indicating unfit quality of water for domestic purposes. Despite such finding no epidemics have been reported here suggesting tolerance for prevalent quality of water.

Introduction

Human civilizations at the banks of rivers have been nurtured by the rivers from time immemorial. India is a nation where rivers and mountains are personified and adorned with mythological tales. Religious significance of rivers in India leads to rites and rituals at the banks of many rivers such as Ganga, Yamuna, Godawari, Cauvery and Narmada (The School Water Portal, 2012). Pilgrims take dip in these rivers to receive blessing of the holy rivers reckoned as goddesses.

During festivals, mass bathing and discharge of worship material in river creates pollution. Discharge of flowers, diya, oil and fat containing materials and so on increase organic matter at the banks of river and also affect microbial flora and small creatures in water.

Idol immersion into river as a religious ritual has been an important cause of pollution and mineral imbalances; although in present times government authorities are concerned and are taking steps to control idol immersion in river (Shukla and Patel, 2015).

While, rivers receive the daily discharge of human and animal wastes from routine local activities, local residents need to be educated regarding long term ill-effects of polluting river water. Bathing, washing clothes using soaps and detergents, discharge of sewage and industrial wastes are a regular burden borne by these rivers.

One of the revered rivers of India is river Narmada. This river is also called the life-line of Madhya Pradesh state of Central India yet suffers thoughtless behavior from human (Deshdeep, 2013). River Narmada originates from Amarkantak (Madhya Pradesh) and mingles with Arabian sea at Gulf of Khambat (Gujrat) covering a course of about 1300 Kms.

Major part of river Narmada spans Madhya Pradesh (MP) and alongside the course of the river many pilgrimage destinations and temples are located. One of such sacred site on Narmada river bank is named Gwari ghat at Jabalpur city of Madhya Pradesh. The present paper is based on the preliminary study of water quality at Gwari ghat.

Along the course of river at Jabalpur city of MP several small and large drains join Narmada river and discharge rain water and sewage from residential and industrial areas. As per information released by Municipal Corporation, Jabalpur, the primary drainage network of Jabalpur City comprises six natural drains, which eventually discharge the city's rainwater into Narmada river. The six primary drains of the city are: Omti nallah; Moti nallah; Urdana nallah; Shah nallah; Khandari nallah; and Pariyat river. There are a total of about 173 secondary drains constructed in different part of the city. These essentially drain water from different areas of the city into primary drains, water bodies and low-lying fields in the outskirts of the city (J.C.D.P., Municipal Corporation Jabalpur, 2012).

Filtration barricades and bioremediation systems have been setup on these drains (nallahs) yet these arrangements are not adequately effective in controlling water pollution of river Narmada. Toxicity to aquatic life by chemical discharge from industries cannot be overlooked and thus efficient measures are required. Xeno-biotics and synthetic antimicrobial agents flowing into the river from city drainage system may not only influence microbial diversity but also induce drug resistance in pathogenic microbes in the stream; channelizing back to human populations. The physico-chemical properties of water are altered by excessive discharge of pollutants into the river disturbing the ecological web of aquatic flora and fauna. Another disproportionate human activity is Sand mining. Whether done legally or illegally, it disturbs the natural river system and destroys the flora and fauna along the river bed (Sand Mining Facts, threeissues.sdsu.edu).

Methods

1. General Survey of River Bank- Gwari Ghat— Permanent and temporary constructions and Human activities at the river bank were observed and their effect analysed.
2. Discussion with Local Residents at Gwari Ghat— Inhabitants at the ghats were inquired about their view regarding human activities and water pollution.
3. Collection of Information from Department of Public Health, Bhopal— Information was collected from Dept of Public Health, Bhopal pertaining to water borne diseases along ghats of river Narmada at Jabalpur city.
4. Survey at Khandari Stream/Nallah [major sewage discharge]— A portion of nallah was surveyed; about one kilometer before it empties into river Narmada.
5. Survey at Khandari Nallah- Narmada River Junction (Setu junction)— The junction was surveyed where the nallah mingles with river Narmada.
6. Water Sample Collection— Water was collected in sterile glass bottles from different locations as mentioned below-
 - I. The proximal bank of river Narmada, at Gwari ghat
 - II. The distal bank of river Narmada, at Gwari ghat
 - III. Khandari nallah -pre remediation at bargi hills,
 - IV. Khandari nallah -post remediation at bargi hills
 - V. Khandari nallah tributary-Narmada river junction (setu junction)
7. Microbial assessment of water samples— 0.5 ml of water sample was spread on selective and differential media – MacConkey's Agar [Himedia: MH081], Eosin Methylene Blue Agar (EMB) agar [Himedia: M317] and Cystine-Lactose-Electrolyte-Deficient (CLED)

w/bromothymol blue agar [Himedia: M792]; at 35°C, in replication. Water sample from Khandari Nallah was diluted with distilled water in proportion 1:2 before spreading 0.5 ml on media plates.

Results and Discussion

General Survey of River Bank- Gwari Ghat—

Narmada river bank named Gwari ghat (Picture no.1) has been developed as a public spot keeping in view the religious rituals frequently pursued by the masses round the year and considerable number of tourists visiting the ghat. On an average day the local residents bathe and wash clothes at the river bank and also use the water for cooking and drinking. While, the tourists are also seen enjoying boating and visiting the temples at the banks of river. One temple is placed in the mid-stream of the river while others are on either side of the river.

At festival time, large number of devotees turn up to pay their rituals at the ghat (river bank). The rituals include bathing in the river and praying to Goddess (River Narmada). In the course of these rituals fragrant sticks, coconut, flowers, diyas and other such materials are used which later remain at the bank or float along. Diyas which are small temporary lamps lit by ghee (milk fat) are allowed to float along the river. Throughout the year, several such festivals are celebrated at Gwari ghat. The present survey was done at the festival named Ganga Dussehra.

Excessive human activities at the river banks and littoral water add to water pollution and affect ecological equilibrium. Researchers report that pH, DO, BOD, COD parameters are affected at incidents of mass bathing. Also total Coliforms were found above the standard limit during and after mass bathing (Telang et al., 2009). Festival rites and rituals by masses at the river Narmada significantly changes physicochemical and microbial characteristics at the banks and littoral zone of river. Patel et al., 2015, have also reported high coliform bacterial loads in the water during festival times which may adversely affect health of pilgrims. It is also observed that as the pollution load increases it takes longer time to recover the previous water quality through self purification process.

Discussion with Local Residents at the Ghat—

The local residents were inquired by the present researcher regarding the pollution levels at the river bank. The residents agreed that the prevailing situation was alarming and there is an urgent need to contain the increasing pollution at the ghat. They were also disappointed that the sewage drains are directed into the river with insufficient sewage treatment. However, the local residents believe that the river has the capacity to neutralize all unhealthy matter merging into the river water. They also stated that they use the river water on daily basis to bathe and even to drink, yet they never suffer illness. Several residents here use the water for drinking and cooking without following any purification method. They believe that the river is their Mother Goddess and will take care of them.

Collection of Information from Department of Public Health, Bhopal (M.P.)—

Information on water borne diseases particularly along ghats of river Narmada at Jabalpur is not available with Department of Public Health but the department has provided a record of Water Borne Diseases linked to open wall water, tanks, ponds, drainage water contamination and flood. Information obtained from department on occurrence of water borne diseases states that there have been considerably growing number of cases but an emergency situation has not been mentioned by the department. As per report provided by the department, acute diarrhoeal diseases, enteric fever, bacillary dysentery and viral hepatitis diseases have been recurrent in the last five years. As per data provided by Dept. of Public Health Bhopal— at Jabalpur city, in 2010, there were 5100 cases of acute diarrhoeal diseases, 976 of enteric fever, 1488 of bacillary dysentery and 62 of viral hepatitis; whereas, in 2015, there were 37578 cases of acute diarrhoeal diseases, 2171 of enteric fever, 5648 of bacillary dysentery and 905 of viral hepatitis. Although there are no reports of any

epidemic of water-borne diseases at the ghats of river in the last five years, the deterioration of water quality and increasing pollution of river water cannot be ignored. The ghat needs a better management and strict rules for the visitors. At the time of festivals, vigilance and prompt cleansing of river bank of all residual material is necessary after the rituals are over. All the sewage drains need to be converged at a treatment plant and only after series of standard treatment methods such water should be released into the river.

Verma and Rawat, in 2014, detected multi drug resistant bacteria in rivers such as Narmada, Yamuna, Ganga and Godavari and mentioned that other than pilgrims, the general human population may be at high risk of suffering from serious diseases due to use of untreated river water regularly for household purposes. Therefore, increased surveillance of surface water and appropriate remedial measures is inevitable.

Survey at Khandari Stream/Nallah [major sewage discharge]—

Khandari stream, which spans a large area of Jabalpur city, is an unloading junction for many small sewage canals and drains. As the Khandari stream progresses towards river Narmada it becomes loaded with considerable quantities of sewage. The stream is also referred as Kandari nallah by the local people. In the area called Bargi hills a sewage canal; Shah nallah, unloads sewage into Khandari nallah. At this place, an in-situ bioremediation sewage treatment system has been setup. Aquatic plants cover the khandari stream along about 300 meters forming an important part of the treatment to reduce organic burden. This bioremediation system extends along the area before and slightly after the junction where sewer from Shah nallah discharges into Khandari nallah. Closely after this junction three filters have been installed transversely to contain suspended solids from the stream of khandari nallah about 1.5 km before it eventually meets River Narmada [at coordinates 23°06 50.4 N 79°53 19.4 E; wikimapia.com]. As evident from Picture no.2A, 2B, water seems to flow over these filters thus a large part of the water in stream moves forward unfiltered.

Srivastava and Pandey (2012) in their paper indicated risk of extracting water borne diseases owing to the presence of exceeding number of fecal coliforms in ground water near nallas (sewage drains) suggesting that such sewer loaded nallas require appropriate treatment at regular intervals along their path before they merge into river Narmada. Similar concern of disease outbreak from contaminated water in populations living at Narmada basin has been raised by Nagpal et al., 2011.

Survey at Khandari Nallah- Narmada River Junction (Setu Junction)—

A bridge (setu) to cross this nallah is built over it at the junction. When the nallah meets Narmada river, it carries along with it heavy loads of dissolved and un-dissolved organic matter derived from sewage disposal of residential area as evident by the turbid grey appearance of the stream mingling with river water (Picture no.2C, 2D). Excessive load of suspended matter at the Setu junction proves that urgent and effective steps for containing river pollution are necessary.

In the study conducted by Sharma et al. (2011) it was concluded that due to discharge of untreated sewage into river Narmada, the water quality of Narmada has severely declined and the potable nature of water is affected. Imbalance in concentration of minerals such as calcium, magnesium, nitrite, sulphate, chloride, phosphate was studied in their research along with dissolved oxygen and turbidity. Under such study it was found that the physicochemical characteristics of Narmada water was disturbed and in certain sampling routines chemical entities crossed maximum permissible limits.

Microbial Assessment of Water Samples Collected from Selected Locations—

When 0.5 ml from each water sample was spread on MacConkey's Agar, EMB agar and CLED w/bromothymol blue agar at 35 °C,

various coliform and non-coliform bacteria were obtained on the media plates indicating high pollution level and low potability standard of tested water. *E. coli* and other enteric bacteria were indicated in most of the tested samples. The probable genera of microbes obtained in preliminary study from heterogeneous water samples have been tabulated here (Table no. 1, Picture no. 3 to 5). On analyzing the tabulated data it is observed that proximal bank of river Narmada at Gwari ghat harbours excessive density of coliforms especially *E. coli*. Various shades of colony types were observed indicating presence of *Klebsiella*, *Salmonella*, *Shigella* and *Pseudomonas* which are a concern for health. While the distal bank at Gwari ghat also showed presence of coliforms in high density. On examining water sample from Khandari nallah prior and post treatment, confluent growth of colonies was observed indicating presence of problematic microbes such as *E. coli*, *Salmonella*, *Klebsiella*; no considerable difference in density of microbes was seen. Similarly, at the setu junction where the nallah empties into the river, confluent growth of indicator microbes was seen on media plates suggesting the failure of water treatment system setup on Khandari nallah

In 2003, MK Gupta reported presence of fecal coliforms, fecal streptococci, *Pseudomonas*, yeasts and moulds at high density in drinking water sourced out from Narmada river. While in 2015, Sharma et al. has stated pathogenic microbial population in Narmada water far beyond normal level pointing towards urgency of pollution control measures. Such findings signify that water quality has not improved over the years. Presence of pathogenic microbes and also toxic chemicals such as fluoride and arsenic may be life threatening to communities residing along the banks of river and using its water for domestic purposes. Organization named Merck Serono India and NGO Narmada Samagra have implemented water health testing project (NRHI, Merck KGaA Germany, 2014) and have shown concern on usability of river water.

It is mentioned by Flint River organization (2011) that while drinking water sample must not contain more than 01 colony per 100ml, if fecal coliform counts are over 200 colonies/100 mL of river water sample, there is a higher probability that pathogenic organisms are also present. And swimming in such water may lead to diseases such as typhoid fever, hepatitis, gastroenteritis and ear infections. W.H.O. has recommended guidelines for evaluation and use of water for drinking (WHO guidelines 4th Ed., 2011) but in practice the general people are not particular about the purity level of water they drink in developing and under developed nations. In the present study, the littoral water at proximal and distal banks of river Narmada at Gwari ghat is not found apt for drinking without treatment. Interestingly, the residents at the river bank claim that they directly use the river water for drinking and other domestic purposes, and yet, they have never suffered water borne diseases.

Seasonal variations in levels of physicochemical factors influence microbial activity. A complex loop of interactions between living and non-living factors decide seasonal characteristics of river water. Kumari et al. (2013) has reported marked seasonal variations in their study on dams built on river Narmada. Such interactions between microbes and minerals in water are influenced by human activities especially regular release of sewage into river. Owing to such human interventions in Natural aquatic system parameters of BOD, COD, DO, pH, turbidity and mineral proportions in the system are disturbed. Soni et al. (2013) has reported considerable distinctions in physicochemical character of Narmada river water due to unwarranted human influences. Srivastava and Athar (2008) have raised concern regarding pollution from dairy farms situated in vicinity of river banks, construction of bridges and other infrastructure on river and its banks. Dairy farms situated on banks of river pollute water in multiple ways, such as, bathing of cattle, discard of animal excreta, waste fodder and waste dairy products into the river water. Continuous and large levels of contamination of water with dairy waste products may disturb the microbial ecosystem at the river banks and littoral region of river.



Picture 1A, 1B: Gwari ghat (Narmada), residual material of rituals performed at the river bank and littoral water
 Picture 1C: Gwari ghat (Narmada) Mass bathing and worship in the littoral water at 'Ganga Dushehra' festival
 Picture 1D: Gwari ghat (Narmada) floating of diyas on water as a ritual



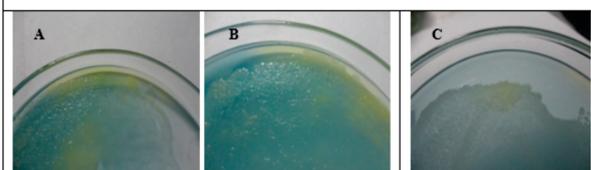
Picture 2A, 2B: Khandari nallah near Bargi Hills; Bioremediation system with transverse filter barricades.
 Picture 2C: Khandari nallah, after crossing bioremediation system and filter barricades, heading to merge with Narmada
 Picture 2D: Khandari nallah merging with Narmada at Setu junction

Picture 3: Colonies on MacConkey's Agar Medium indicating mixed microbial flora of Enteric bacteria and some others such as *Pseudomonas*



Picture 3A: Sample from Khandari nallah [post filtration]; Variety of colonies appearing translucent pale to whitish cream to pink colour with varied consistency are visible: <i>Salmonella</i> , <i>Shigella</i> , <i>E. coli</i> , <i>Pseudomonas</i> , <i>Serratia</i> are indicated	Picture 3B: Sample from Gwari ghat [proximal bank]; Pink growth with dye accumulation, whitish to translucent irregular growth with moist to mucoid consistency is visible: <i>Klebsiella</i> , <i>Serratia</i> , <i>E. coli</i> are indicated	Picture 3C: Sample from Gwari ghat [proximal bank]; Flat irregular glistening film of growth indicates <i>Pseudomonas</i> along with other non lactose fermentors.
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Picture 4: Colonies on CLED/w Bromothymol blue Agar Medium shows presence of *Enterobacteria* as indicated by colonies in shades of yellow



Picture 4A: Sample from Gwari ghat [proximal bank] Picture 4B: Sample from Setu junction Prominent yellow colonies, translucent to cream colonies are visible: <i>E. coli</i> , <i>Enterococcus</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Proteus</i> , <i>Staphylococcus</i> are indicated	Picture 4C: Sample from Khandari nallah [pre-filtration]; gray growth with yellowish tint: <i>Klebsiella</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Proteus</i> , <i>Enterococcus</i> are indicated
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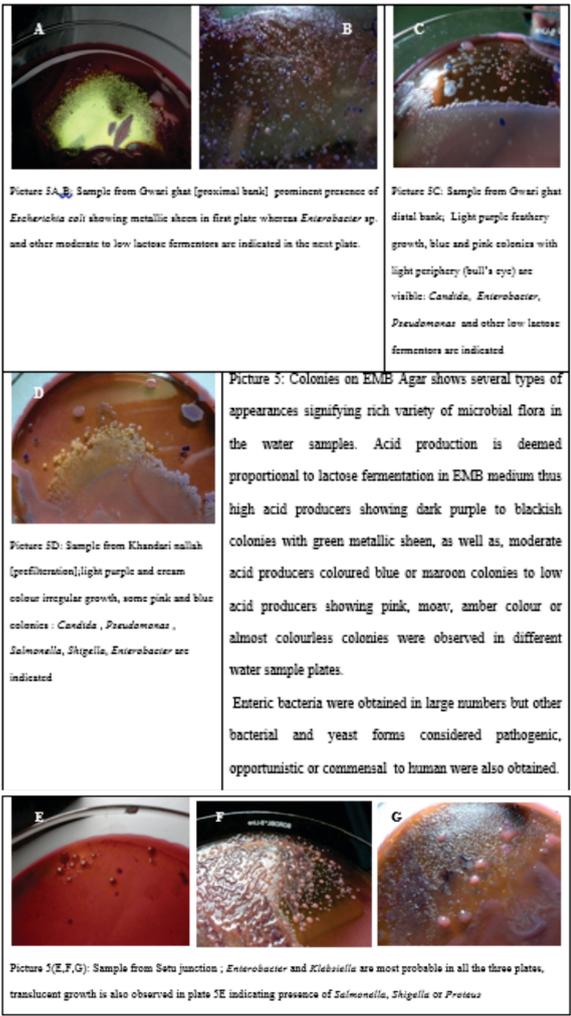


Table 1: Preliminary study on water quality of Narmada River
 Sample from flowing turbid water was obtained from different locations of river and its tributary stream (Khandari); water samples were spread on selective/differential agar media in replicate sets for assessment under three levels of microbial density.

Location	Selective /Differential Agar Media	Density of probable micro-organisms per 0.5 ml water sample		
		High [more than 50 colonies]	Moderate [15- 49 colonies]	Low [less than 15 colonies]
River Narmada-Gwari ghat , proximal bank	MacConk ey's	<i>E.coli</i>	<i>Klebsiella, Pseudomonas Salmonella , Shigella, Proteus</i>	-----
	EMB	<i>E.coli</i>	<i>Enterobacter, Klebsiella Salmonella, Shigella , Proteus</i>	<i>Pseudomonas , Candida</i>
	CLED	<i>Proteus, E. coli</i>	-----	<i>Klebsiella</i>

River Narmada-Gwari ghat, distal bank	MacConk ey's	<i>Salmonella, Shigella</i>	<i>E.coli</i>	-----
	EMB	<i>Pseudomonas , Candida E.coli</i>	-----	<i>Salmonella Shigella Enterobacter</i>
	CLED	<i>Proteus, E.coli</i>	-----	<i>Corynebacteria</i>
Setu Junction - [Khandari nallah – Narmada river junction]	MacConk ey's	<i>E.coli Klebsiella</i>	<i>Pseudomonas Salmonella, Shigella</i>	-----
	EMB	<i>E.coli Salmonella,</i>	<i>Yeasts/ Pseudomonas Enterobacter</i>	<i>Klebsiella</i>
	CLED	<i>Enterococcus Corynebacter</i>	<i>Klebsiella E.coli</i>	-----
Khandari Nallah-prior filter barricade	MacConk ey's	<i>E.coli Salmonella, Shigella</i>	<i>Non lac ferm-Serratia, Yersinia, Pseudomonas</i>	-----
	EMB	<i>Proteus Salmonella, Shigella Pseudomonas, Candida</i>	<i>Enterobacter Klebsiella</i>	-----
	CLED	<i>Proteus, E.coli Salmonella, Shigella</i>	-----	-----
Khandari Nallah-post filter barricade	MacConk ey's	<i>Salmonella, Shigella E.coli</i>	<i>Klebsiella Citrobacter Aerobacter</i>	-----
	EMB	<i>Proteus E.coli</i>	-----	<i>Enterobacter Klebsiella</i>
	CLED	<i>Salmonella Proteus</i>	<i>E.coli</i>	-----

Conclusion:
 Deterioration of Narmada river water quality has speeded with increased human activities at the river banks which directly or indirectly influence the ecological equilibrium of river. Concrete constructions at the flood plains, dams on river and excessive dumping of domestic and industrial wastes into the river are activities that are difficult to deal with. It is essential to treat sewage effectively through a comprehensive plan utilizing physical and biochemical methods at appropriate positions on the nallahs before they mingle with the river. The local residents also need to be acquainted with the ill effects of regularly contaminating river water

with detergent, agricultural pesticides, dairy wastes and customary religious materials. Vigilance at the banks of river at festival times, imposing stricture on the defaulter visitors at the banks along with sieving out of floating garbage and use of scavenger fishes are some of the steps which may prove effective. Controlling sand mining from river bed is also necessary to protect the natural flow and ecological system of river.

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