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Seasonal Evaluation of Microbiological Status of Groundwater in Industrial Estate of District Raisen-464551 Madhya Pradesh (India)

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Abstract

One of the major challenges of modern time is the bacteriological contamination in drinking water which is becoming a growing concern throughout the world. The presence of microorganisms poses a threat to water quality due to its capability to cause most of the waterborne diseases. The main objective of current study was to determine the microbiological status of groundwater of twenty-four selected sites of rural area of Mandideep industrial estate of district Raisen for drinking purpose. T. coli, F.coli and F. streptococcus were studied by using multiple tube fermentation technique method for premonsoon, postmonsoon and winter season. The results were analysed following the drinking water standards as per IS10500: [12] and WHO,[24]. It was observed from the results that highest concentration of these bacteria was found in postmonsoon season in comparison to winter and premonsoon season. It construed as a warning of presence of pathogenic bacteria and great risk of health issues and disease breakouts.Thus, it is desirable to identify and eradicate the sources of bacterial contamination andcontinuous disinfection of water is necessary for ensuring safe drinking water for human consumption.

Water as a natural resource is globally sine qua non for life on earth and groundwater is a vital source of drinking water and much of the world's population depends on this natural resource for human consumption[8]. In Indian villages, people rely heavily on groundwater as a source of drinking water and other domestic purposes. But the contamination of groundwater is deteriorating the quality and making it unsuitable for drinking purpose. Various factors contribute to the contamination like unplanned urban development without adequate attention to sewage, waste disposal and dischargeinto pits, open ground, orunlined drains. In rural areas, the excessive use of fertilizers and other insecticides for a long duration coupled with over irrigation is also contributing to the groundwater pollution[18].

Many micro-organisms may be present in drinking water that may deteriorate its quality and make it unsuitable for human

consumption and may lead to many waterborne disease's outbreaks[10]. The principal risks to human health are microbiological in nature. The WHO guidelines for drinking water quality, 1997 provided that in developing countries, an estimated 80% of all diseases and nearly one-third of deaths are caused by the consumption of contaminated water.

The microbial contamination in rural areas is due to the faecal pollution from different sources, most frequently livestock and inadequate on-site human waste disposal systems[6,9,23]. Many organisms likecoliform group of bacteria are used as an indicator for determining the contamination of water by faecal matter or by other sources. The microbial analysis of water determines its potability and sanitary quality[10].

In living organisms including humans, coliforms are normal inhabitants of digestive tracts and are found in their wastes, besides soil material[20]. They are also considered as 'indicator organisms' of water pollution caused by faecal contamination and pose a threat for contracting diseases from pathogens[19].

The objective of the conducted study is to evaluate the microbiological status of groundwater of villages in the industrial estate of Mandideep of Raisen district for the purpose of drinking and domestic use.

Study area :

Raisen district lies in the central part of the Madhya Pradesh and is situated between the latitude 22° 47' and 23° 33' north and the longitude 77° 21' and 78° 49' east. It covers an area of 8,395 square kilometres (3,241 sq. mt.). The geographical area of the district is 8466 sq.km, out ofwhich 28812 hectares is non- cultivable land, out of which 4638 hectares fallow land can be utilized for industrial development.Raisen was an industrial backward district and due to availability of fallow land in Goharganj tehsil, most of the industrial units/factory were concentrated in Mandideep industrial growth centre in Obedullaganj block.

In the present study, Mandideep industrial estate was chosen as there is concentration of industries in this centre. Twelve villages from this area were undertaken for study as shown in Fig 1 and two sites from each of the villages were selected. Thus, in aggregate, twenty-four sites were assessed for evaluation of groundwater quality.

Before collecting samples, water was pumped out for about 5-10 minutes or until water temperature was stabilized. For bacteriological analysis, water samples were collected in pre-sterilized borosilicates glass bottles. The samples were preserved in icebox and transported to laboratory within three hours from the time of collection. The samples wereanalyzedfor Total coliform, Faecal coliform and Faecal *Streptococcus* by using multipletube fermentation technique[2] for three seasons postmonsoon, premonsoon and winter for a period of two years from 2018-2020. The results obtained were compared with the drinking water standards as per Bureau of Indian Standards (BIS) for drinking water[12,24].

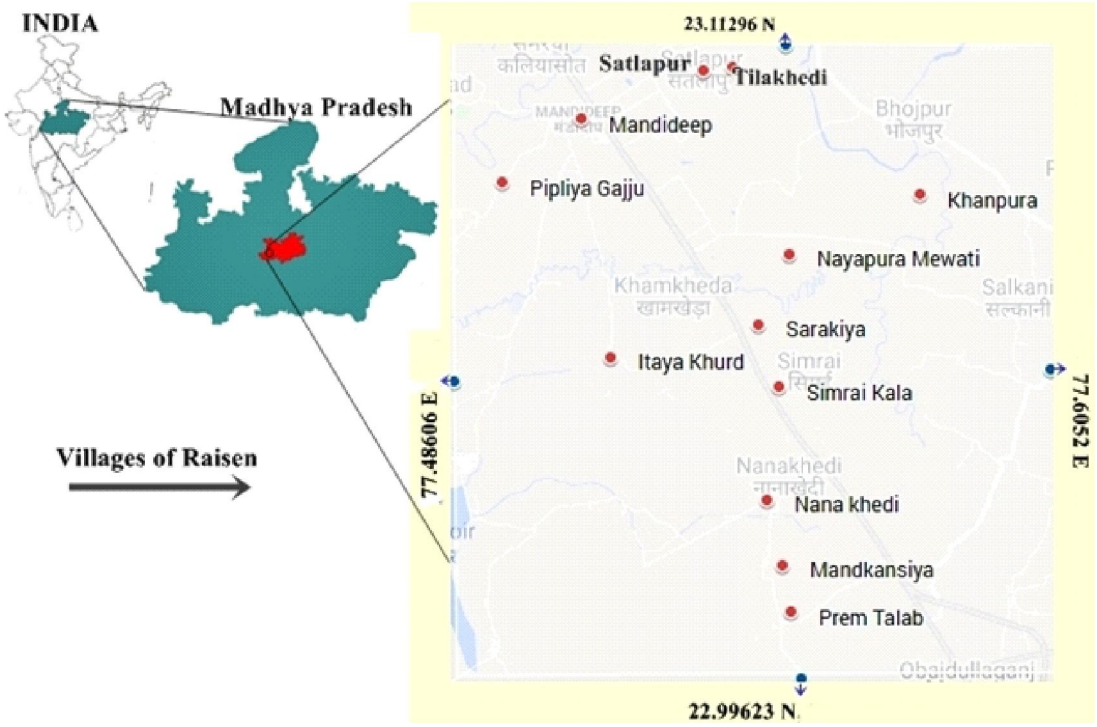

Fig 1: Sampling sites of Industrial area

Coliforms are facultative anaerobic, rod shaped, Gram-negative, non-spore forming bacteria that ferment lactose with gas and acid formation within 48 hours at 35°C (APHA)[2]. These are usually present in digestive tracts and faecal waste of warm-blooded animals and may or may not indicate the faecal contamination but in general, reflects the sanitary condition of water supply. This could be due to entry of soil or organic matter into the water or by conditions suitable for growth of other types of coliforms[7].

The results of Table-1 showed the range and average value of *T. coli, F. coli* and *F. streptococcus* in different seasons. The average count of *T. coliform* was observed to be 6.06, 6.83 and 6.39 MPN/100ml in premonsoon, postmonsoon and winter season respectively. The maximum value was found 12 MPN/100 ml in postmonsoon season. Faecal coliforms which denotecoliform organisms grow at about 44.5°C, more commonly known as 'thermotolerant coliform' and its presence indicates faecal contamination[7]. The average count of F. coliform was observed to be 3.85, 4.31 and 3.98 MPN/100ml in premonsoon, postmonsoon and winter season respectively. This may be attributed to the potential source of contamination like septic tanks, soak pits, water logged areas etc in the vicinity of the studied area[10]. It was observed in the study area that cattle faeces and urine in domestic animal sheds and mound of cow

dung may cause groundwater contamination. Another factor was due to improper drainage facilities in some of the villages, the drainage water was collected in the abandoned ponds and its continuous percolation in groundwater may contribute to the contamination.

The growth of slum near Industrial area on account of relocation and high density of the labour class augmented the problem of sanitation, proper drainage and affected the domestic water supply. Over a period of time, unplanned colonies, contamination by open lavatories etc also contributed contamination of groundwater in that area.

Faecal Streptococci are a group of Gram positive coccoid bacteria and its presence is indicative of faecal contamination. It is relatively in high concentration in excreta of humans and other warm-blooded animals in comparison to coliforms. It has also the tendency to persist longer in environment without multiplication[14].

The average count of F. streptococci was detected to be 1.9, 2.17 and 2 MPN/100ml in premonsoon, postmonsoon and winter season respectively. The minimum concentration was found 1.8 in premonsoon and the maximum 3.7 was observed in postmonsoon season. The presence of this bacteria may be attributed to seepage or percolation from the unlined septic tanks and sewer system near the water suction line of handpumps or borewells, especially found in overpopulated areas[16].

The presence of these bacteria in drinking water must be nil according to drinking water quality standard IS: 10500: 2012 and WHO,1996.But its presence by animal faecal contaminationcould result in waterborne diseases such as diarrhoea, typhoid, hepatitis etc. The high coliform population in water samples was an indication of poor sanitary conditions and improper handling of solid wastes in rural areas could have generated high concentration of microbial organisms[1,22].

Table-1. Seasonal variation of MPN count in Industrial Area

Bacteria	Season	Range(MPN/100ml)	Average(MPN/100ml)
T. coliform	Premonsoon	1.8-11	6.06
	Postmonsoon	2-12	6.83
	Winter	2-11	6.39
F. coliform	Premonsoon	1.8-6.8	3.85
	Postmonsoon	1.8-8.3	4.31
	Winter	1.8-8.2	3.98
F. streptococcus	Premonsoon	1.8-2	1.9
	Postmonsoon	2-3.7	2.17
	Winter	2-2	2

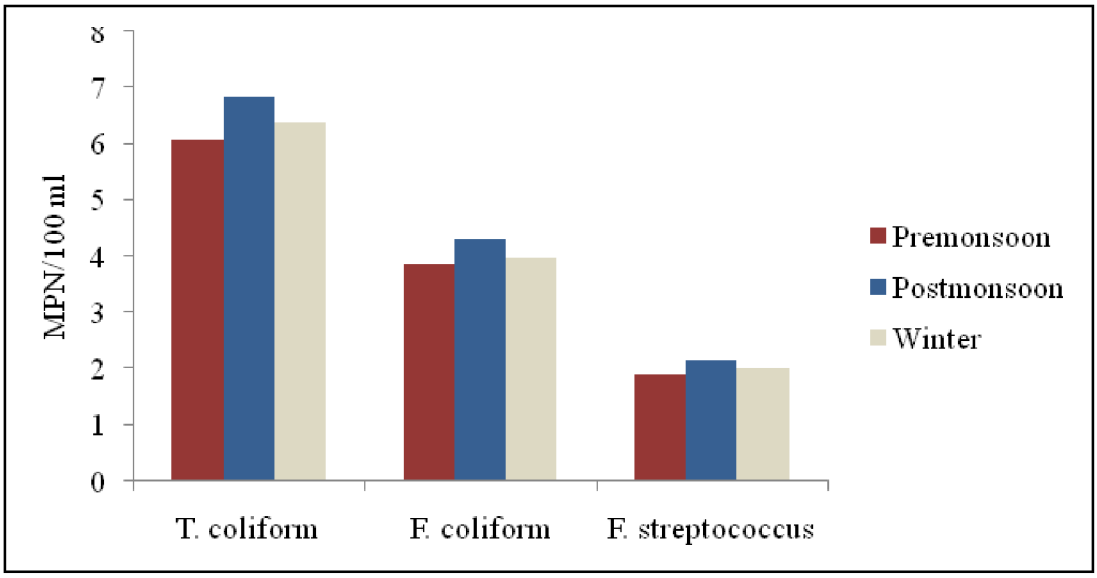

Fig. 2. Seasonal variation of MPN in different bacterial count in Industrial Area

The average value of *T. coli*, *F. coli* and *F. streptococcus* in different seasons depicted that low count of bacteria was found in premonsoon season and highest count was observed in postmonsoon season. The low count in premonsoonwas due to the decrease in groundwater level and evaporation of the domestic sewage on account of intense heat in the summer season[8]. The higher count of bacteria was found during postmonsoon season due to lack of proper drainage facilities for disposal of domestic wastewater in rural areas. During rainy season, bathroom sewage, pit latrine, kitchen & bathroom discharge washed away and percolates through the ground which ultimately leaches to the groundwater[11].

The present studies found support from concurrent findings observed in Nanded, Maharashtra[8], Goa[11], Pondicherry-Tamil Nadu[22], Vellore, Tamil Nadu[2], Thrissur, Kerala[4].

The investigation of the present studies has indicated that the most of the sampling sites were not suitable for drinking purpose and this posed a potential risk to the human health. The microbial contamination has arisen from a variety of sources and it has become essential to apply adequate preventive measures to prevent the groundwater from such contamination. The studies have further emphasized on the need of disinfect groundwater and tap water before human use in order to avoid health hazards to human being.

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