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# STUDY OF THE GROUNDWATER QUALITY CONTAMINATED WITH SUGAR MILL EFFLUENT

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## ABSTRACT

A study was made in the industrial areas of Balrampur where the effluents from a sugar mill were polluting groundwaters. Physico-chemical and microbial analysis was conducted in groundwater samples. It was indicated that EC, TDS, total hardness, BOD, COD, calcium, potassium, bicarbonate, chloride and nitrate levels were on the higher side of permissible limit of WHO standards. Balrampur is regarded as a major industrial city knowing well for its sugar mill that is the largest sugar mill of Asia by the production point of view. Groundwater resources were found polluted by different inorganic and organic pollutants, which were discharged from sugar mill. Polluted groundwater may result in various health problems.

## INTRODUCTION

Of the total amount of global water, only 2.4% is distributed on the main land, of which only a small portion can be utilized as freshwater. The available freshwater to man is hardly 0.3-0.5% of the total water available on the earth and, therefore, its judicious use is imperative (Hegade & Kale 1995). The freshwater is a finite and limited resource. The utilization of water from ages has led to its overexploitation coupled with the growing population along with improved standard of living as a consequence of technological innovations (Todd 1995, Indra Raj 2000). The contamination of groundwater is not away from the evils of modernization. Therefore, quality of groundwater is deteriorating at a faster pace due to pollution ranging from septic tanks (Gillison & Patmont 1983), land fill leachates, domestic sewage (Eison & Anderson 1980, Sharma & Kaur 1995, Subba Rao & Subba Rao 1995), agricultural runoff/agricultural fields (Banerji 1983, Handa 1986, Ramchandra et al. 1991, Datta & Sen Gupta 1996) and industrial wastes (Sharma & Kaur 1995, Todd 1995, Indra Raj 2000). Contamination of groundwater also depends upon geology of the area, especially in lime stone regions where extensive cavern systems are below the water table (Singh 1982). This is a feature common, not only in developed countries, but also in developing countries like India. The changes in quality of groundwater are mainly due to variation in physical, chemical and biological environment through which it passes.

Groundwater resources in Balrampur are widely exploited for irrigation and domestic purposes. The people of Balrampur are mainly depending on groundwater for their drinking water. The present study deals with the quality of ground water near industrial area of Balrampur. Balrampur has a major sugar mill, which discharges its effluent into River Rapti through different channels and nullahs. Groundwater and soil in the adjoining areas were found severely affected by various inorganic and organic pollutants. Effluents discharged from sugar mill carry a vast load of different pollutants. After percolation and leaching, these pollutants come in contact with groundwater and deteriorate its quality. The present study was undertaken with an aim to assess the level to which the pollution has affected various physico-chemical properties of groundwater.

## MATERIALS AND METHODS

The groundwater samples were collected from Naharbalaganj (Site I), Sunwav Nalah (Site II), Bhagawatiganj Market (Site III), Dharampur (Site IV) and Ghelhapur (Site V). The samples were stored in pre-sterilized 500 mL glass bottles with essential precautions and brought to laboratory and analyzed for the parameters selected using standard method (Trivedy & Goel 1984, APHA 1992). Hydrogen ion concentration (pH) and dissolved oxygen (DO) were measured on the spot at the time of collection, the other parameters like electrical conductivity (EC), total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total hardness, calcium ($Ca^{++}$), sulphate ($SO_4^{-2}$), chloride ($Cl^-$) and nitrate ($NO_3^-$) were analyzed in laboratory within 24 hours of sample collection. The water pollution may have a direct relationship with these parameters if they are found beyond permissible limits (Trivedy & Goel 1984).

## RESULTS AND DISCUSSION

The various physico-chemical parameters were determined for the sugar mill effluent polluted groundwater samples at five sites as given in Table 1 and Fig. 1.

pH of groundwaters is decided by a particular set of chemical conditions. The pH value of groundwater samples varied from 6.5 to 6.8 at different sites of the study area. Therefore, the groundwater was considered as slightly acidic. Electrical conductivity (EC) is current carrying capacity that gives a clear idea of soluble salts present in groundwater. The EC values of contaminated groundwater samples varied from 1710 to 3220 µmhos/cm, which were higher than the WHO permissible limit (Kalyanraman et al. 1998). TDS values of polluted groundwater samples were found between 1637 and 1978 mg/L, while TDS limit as per WHO permissible limit is between 850 and 1500 mg/L. The total hardness of the groundwater samples varied from 840-1250 mg/L. BOD is an amount of oxygen utilized by microbes present in stabilizing organic matter. In the present study DO values were found from 6.0 to 9.0 mg/L, which were higher than WHO permissible limit. COD is a

Table 1: Comparative assessment of physico-chemical parameters of groundwater samples (WHO standards are as mentioned by Trivedi & Goel 1984).

| Parameters | Study Areas | | | | | WHO Standards |
|---|---|---|---|---|---|---|
| | Site I | Site II | Site III | Site IV | Site V | |
| pH | 6.5 | 6.4 | 6.4 | 6.7 | 6.8 | 7.0-8.5 |
| EC (µmhos/cm) | 3220 | 2320 | 2180 | 1860 | 1710 | 500-1500 |
| TDS (mg/L) | 1978 | 1932 | 1637 | 1748 | 1829 | 850-1500 |
| DO (mg/L) | 6 | 6 | 9 | 7 | 8 | 6 |
| COD (mg/L) | 400 | 380 | 240 | 280 | 280 | 10.0 |
| TH (mg/L) | 1250 | 1140 | 840 | 980 | 940 | 500 |
| $Ca^{++}$ (mg/L) | 360 | 280 | 200 | 210 | 200 | 100 |
| $Mg^{++}$ (mg/L) | 95 | 90 | 84 | 94 | 90 | 150 |
| $Na^+$ (mg/L) | 190 | 180 | 113 | 192 | 176 | 200 |
| $K^+$ (mg/L) | 123 | 102 | 48 | 70 | 46 | 5-10 |
| $HCO_3^-$ (mg/L) | 675 | 565 | 415 | 620 | 520 | 50 |
| $CO_3^{-2}$ (mg/L) | 54 | 46 | 32 | 56 | 38 | 200 |
| $SO_4^{-2}$ (mg/L) | 19 | 17 | 15 | 10 | 10 | 250 |
| $Cl^-$ (mg/L) | 213 | 314 | 617 | 390 | 514 | 250 |
| $NO_3^-$ (mg/L) | 110 | 120 | 150 | 110 | 160 | 50 |

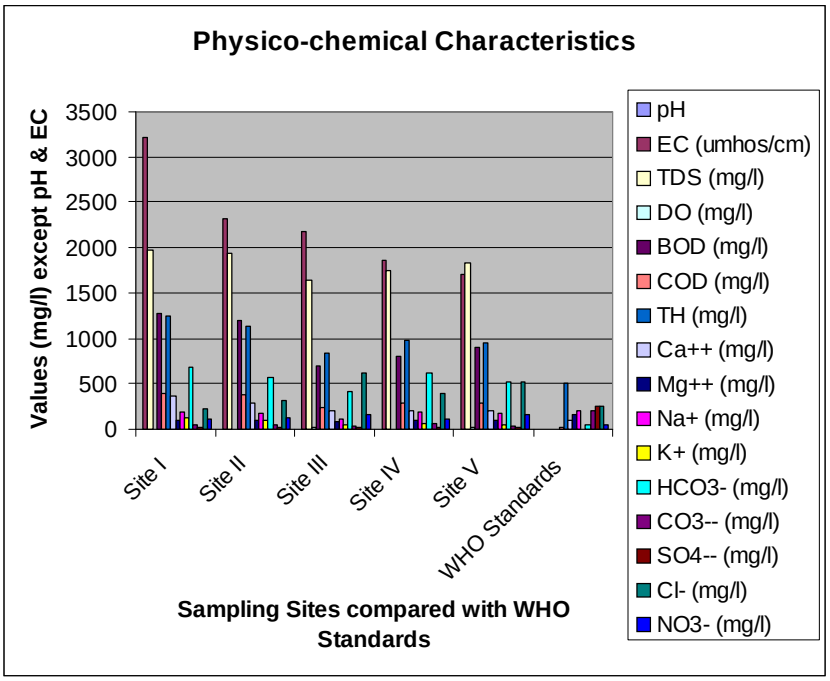


Fig. 1: Physico-chemical characteristics of groundwaters.

measure of oxidizable impurities. The estimated COD values were between 240 and 400 mg/L. The variations were due to presence of different organic compounds in sugar mill effluent (Jessudas & Akaliya 1996). The calcium content of groundwater varied from 200 to 360 mg/L, which was higher than the WHO permissible limit of 100 mg/L. The magnesium content varied from 84 to 95 mg/L which was normal as per WHO permissible limit of 150 mg/L. The concentration of sodium ranged from 113 to 192 mg/L. These values were below WHO permissible limit (200 mg/L). The potassium fluctuated from 46 to 123 mg/L, which was higher in comparison to WHO permissible limit of 5 to 10 mg/L.

Bicarbonate and carbonate varied from 415 to 675 mg/L and 32 to 56 mg/L respectively. These values were higher than the WHO permissible limits. Sulphate, chloride and nitrate concentrations in groundwater varied from 10-19, 213-617 and 110-160 mg/L respectively. Thus, sulphate concentration was well below WHO permissible limit, whereas chloride and nitrate values were much higher than the WHO permissible limit.

The groundwater to be used for drinking purpose should be free from microbial population, colour, turbidity and hardness. The samples of polluted groundwater tested for the present study do not possess this quality.

On the basis of these physico-chemical characteristics, it was concluded that the groundwater in the vicinity of sugar mill was highly polluted due to higher concentration of TDS, calcium, potassium, bicarbonate, chloride and nitrate, which were greater than WHO permissible limits and might be cause of following health problems:

- Higher TDS levels may lead to adverse physiological effects like gastro-intestinal irritation, etc.
- Carbonate and bicarbonate may also lead to gastro-intestinal disorders.
- Higher level of calcium and potassium in groundwater may cause urinary disorders.
- Nitrate absorbed in blood may lead to a severe disease called methaemoglobinaemia in infants.
- In the present study certain bacteria might also be the cause of various gastro-intestinal disorders in consumers.

The present study clearly indicates that the groundwater near the sugar mills do not meet the drinking water standards. Once groundwater is contaminated, it is very difficult to restore its fundamental characteristics. Efforts should be made for proper treatment, management and disposal of sugar mill effluents to prevent deterioration of groundwater quality in the affected area.

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