

**Research Article**

**PHYSICO-CHEMICAL, BACTERIOLOGICAL AND PESTICIDE  
ANALYSIS OF TAP WATER IN THE CITY OF NOIDA,  
(UTTAR PRADESH) INDIA**

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**ABSTRACT**

In the modern era of industrialization, due to increase in the developmental activities, water is being polluted. It is essential to monitor and prevent the pollution load in drinking water as it has a direct link to human health. The objective of this study was to determine physico-chemical characteristics, bacterial contamination and pesticides in tap water samples collected from various selected sites of Noida City. Tap water samples were assessed for physico-chemical parameters like; pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Hardness, Alkalinity, Fluoride (F), Nitrate ( $\text{NO}_3^-$ ) and Sulfate ( $\text{SO}_4^{2-}$ ). The water samples were also analyzed for the presence of fecal bacteria namely: Escherichia coli (E.coli), Salmonella, Pseudomonas aeruginosa, Staphylococcus aureus and total coliform bacteria present in tap water. Pesticides namely : Chlorobenzilate, Hexachloro-benzene, Benzenether, pp-DDT, op-DDT, pp-DDE, pp-DDD, alpha-HCH, Beta-HCH, Lindane, Vinclozolin, Conumaphos, Malathion, Phosalone, Cyfluthrin, Cypermethrin, Deltamethrin, Permethrin, Fenvalerate, Fluvalinate, Cyhalothrin, Carbofurn, Propoxeur, Carbaryl, Cymiazol, Amitraz, Bromprophylate, Chinomethionate were also detected.

**Key Words:** *Physico-Chemical Parameters, Fecal Bacteria, Total Coliform Bacteria, Pesticides, Noida City etc*

**INTRODUCTION**

Water is a Universal and potent symbol of life. Unsafe water causes about 4 billion cases of diarrhea per year which results in one and half million deaths mostly of children under the age of five. In India, half a million children die every year due to unsafe drinking water (UNICEF/WHO, 2009). Everyday tons of sewage and industrial waste are being discharge into our surface and sub surface water resources. The signs of water pollution are bad taste, offensive odours, oil or grease floating over water etc. In general water pollutions is a state of deviation from pure condition, whereby its normal properties and functions are affected. Noida is a heavily populated and industrialized city. It becomes important to measure the toxicity of drinking water on regular basis to sufficiently support human health risk assessment and to match National as well as International standards that have been set for drinking water.

**MATERIALS AND METHODS**

***Experimental***

A study was undertaken from October 2010 to October 2011 and seventy eight tap water samples (tap water) were analyzed to obtain monthly variations in the quantity of physico-chemical parameters, bacterial contamination and pesticides at all study sites. The study sites were chosen to give representation of all areas.

***Location of Study Sites with Map***

Location of study sites with map is shown in Figure 1

***Noida (Uttar Pradesh)***

**Location 1 :** RKG Mansion, Sec.-18, Atta Market

**Location 2 :** Sector-34 Colony

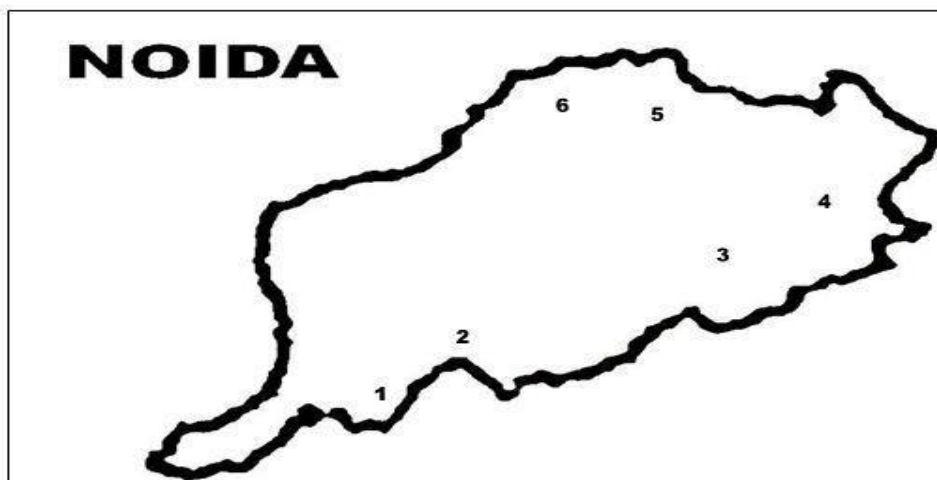
**Location 3 :** Sector – 50.

### Research Article

**Location 4 :** IMS, Institutional Area, Sec.-62.

**Location 5 :** Sector – 63.

**Location 6 :** Sector – 64.



**Figure 1: (Location of Study Sites)**

### Sampling

Sampling for water analysis was done aseptically with care, ensuring that there was no external contamination of samples. For analysis, sterilized plastic bottles were used which were sterilized by boiling for 15 minutes and rinsed with distilled water. Effectiveness of sterilization was checked with each run by using sterilization strips (commercially available) inside sampling bottles. During sample collection, some air space was left in the bottle to facilitate mixing by shaking, before examination. Tap is open fully and water was allowed to run for 2-3 minutes and then flow of water was reduced to permit filling of water samples.

**Table 1: Physico-chemical properties of the water samples**

Parameter	Units	Methods	Section No. APHA (1998) / Other Related Methodologies
pH		Electrometric Method	4500 – H+ B
Dissolved Oxygen (DO)	mg/L	Titrimetric Method	4500 – O B
Total Dissolved Solids (TDS)	mg/L	Gravimetric Method	2540 B
Total Hardness	mg/L	EDTA Titration Method	2340
Alkalinity	mg/L	Titration Method	2320 A
Fluoride (F <sup>-</sup> )	mg/L	Ion-Selective Electrode Method	4500 – F– C
Nitrate (NO <sub>3</sub> <sup>-3</sup> )	mg/L	Cadmium Reduction	4500 – NO3– - E
Sulfate (SO <sub>4</sub> <sup>-2</sup> )	mg/L	Turbidimetric Method	4500 – SO4–2 E
Fecal Bacteria	MPN/100mL	E.coli Procedure	9221F
Total Coliform	MPN/100mL	Multiple-tube fermentation technique	9221-A
Pesticides	ppm	GCMS (Gas Chromatography Mass Spectrometer)	Thermo Finnegan

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### **RESULTS**

The monthly variation in the physico-chemical parameters of tap water samples observed at all sites are presented in Tables 1 to 8 from October 2010 to October 2011.

#### **pH Value**

pH reveals if a solution is acidic or alkaline. pH of water beyond permissible range can affect mucous membrane of cells and cause corrosiveness in water supply system (Course manual for chemists and bacteriologist of PHED laboratories under National Drinking Water Quality Monitoring and Surveillance Programme 2012). The range of minimum and maximum seasonal average temperature of water samples was recorded as follows:-

Site 4	:	6.74	(October – December 2010) –
		6.75	(January – June, 2011) to
Site 1	:	6.83	(January – June 2011) –
		6.88	(October – December 2010).

#### **Dissolved Oxygen (DO)**

Dissolved Oxygen (DO) or Oxygen saturation is a relative measure of the amount of oxygen that is dissolved in water. Oxygen gets dissolved in water by diffusion from surrounding air or as a waste product of photosynthesis. Evaluation of water samples collected from various areas of Noida showed a range of minimum and maximum seasonal average of DO which is shown below:

Site 2	:	2.67 mg/L	(October – December 2010) –
		5.38 mg/L	(July – September 2011) to
Site 3	:	2.38 mg/L	(July – September 2011) –
		4.35 mg/L	(October – December 2010)

#### **Total Dissolved Solids (TDS)**

Total Dissolved Solids (TDS) is a measure of the combined content of all organic and inorganic substances contained in water. It is generally considered as a primary pollutant and is used as an indicator of aesthetic (Dezuane, 1997). Evaluation of Total Dissolved Solids (TDS) of water samples collected from different regions of Noida showed minimum and maximum seasonal average levels of TDS as follows:

Site 5	:	65 mg/L	(April – June 2011) –
		67 mg/L	(October 2010 – March 2011) to
Site 4	:	123 mg/L	(January – September 2011) –
		124 mg/L	(October – December 2010)

#### **Total Hardness**

Hardness is the amount of calcium and magnesium salts dissolved in water. It has no health effects except for imparting taste (WHO, 1996). The seasonal average range of total hardness of water samples collected from different areas of Noida was:

Site 6	:	17.3 mg/L	(October – December 2010) –
		18.7 mg/L	(April – June 2011) to
Site 3	:	38.7 mg/L	(January – March 2011)
		40.3 mg/L	(October – December 2010)

#### **Alkalinity**

Alkalinity is an ability of water to neutralize acids to equivalence point of carbonates or bicarbonates. Anaerobic degradation process taking place in water have an impact on alkalinity of water (Thomas and Schietecatte, 2008). The range of minimum and maximum seasonal average of alkalinity of the water samples was recorded as follows:

Site 1	:	37 mg/L	(October 2010 – June 2011)
		38 mg/L	(June – September 2011) to
Site 2	:	80 mg/L	(July – September 2011)
		83 mg/L	(October – December 2010)

## **Research Article**

### **Nitrate**

Surface water contains nitrate due to leaching of nitrate with the percolating water. Surface water can also be contaminated by sewage and other wastes rich in nitrates. Consumption of nitrates above permissible limits causes methaemoglobinemia popularly known as Blue Baby Syndrome (Basic information in nitrates in drinking water, 2012). The seasonal average minimum and maximum values of nitrates present in these water samples are summarized below:

Site 6	:	0.02 mg/L	(Oct. – Dec. 2010, April – June 2011) –
		0.03 mg/L	(January – June 2011)
Site 1	:	0.08 mg/L	(October – December 2010) –
		0.06 mg/L	(April – June 2011) to

### **Sulfate**

Sulfates which are a form of sulfur get into the water supply when sulfite ores are oxidized. Sulfur containing minerals are found in most of the rocks and soils around the world. As ground water seeps through the earth, some of these compound is sulfur are dissolved by the water. Rain water that leaches into the ground is also a source of sulfur. The biggest problem of sulfur in drinking water is that it stinks. Drinking water which has high level of sulfate can cause diarrhea, especially in infants (EPA, 2010). The minimum and maximum seasonal average values of sulfates recorded in the water samples are as follows:

Site 6	:	3.0 mg/L	(October – December 2010) –
		3.1 mg/L	(January – March 2011) to
Site 4	:	5.0 mg/L	(January – March 2011) –
		5.2 mg/L	(July – September 2011)

### **Fluoride**

Exposure to excess consumption of fluoride over some period may lead to increased chances of bone fractures, pain in bones and tenderness in adults. Young children exposed to excess amounts of fluoride have a chance of developing pits in tooth enamel (US-EPA, 2010). Area wise analysis of water revealed following range in the levels of fluoride:

Site 2	:	0.023 mg/L	(October – December 2010) –
		0.04 mg/L	(April – June 2011) to
Site 4	:	0.037 mg/L	(April – September 2011) –
		0.053 mg/L	(October – December 2011)

### **Bacteriological Analysis**

Safety of drinking water against bacterial contamination is extremely important as human health is involved. Bacterial contamination in drinking water is a cause of concern not only for under developed and developing country but also to the developed world. Bacterial safety of water can be achieved by the use of multiple barriers from catchment to consumer, protection of water sources against pollution, proper selection and operation of treatment, healthy distributive system etc. to maintain effectiveness of treated drinking water. By the bacterial contamination in drinking water is detected, many people are already exposed (Singh, 2006). Seventy eight drinking water samples collected from various sites of Noida were tested for the presence of E.coli, Salmonella, Pseudomonas aeruginosa and Staphylococcus aureus. All drinking water samples showed negative results for the presence of the above mentioned fecal bacteria. However, bacteriological tests conducted on water samples revealed presence of total coliform bacteria. Results of MPN for drinking water samples collected from this area showed MPN range of 2–14/100 mL. Bacterial contamination above BIS permissible limits was observed in 24 drinking water samples as shown below:

Site 1	:	4/100 mL	(February 2011)
		2/100 mL	(March 2011)
		14/100 mL	(June 2011)
		6/100 mL	(September 2011)
Site 2	:	9/100 mL	(October 2010)

## **Research Article**

		11/100 mL	(December 2010)
		4/100 mL	(March 2011)
		2/100 mL	(July 2011)
Site 3	:	7/100 mL	(December 2010)
		11/100 mL	(March 2011)
		2/100 mL	(April 2011)
		12/100 mL	(July 2011)
Site 4	:	4/100 mL	(December 2010)
		2/100 mL	(January 2011)
		7/100 mL	(May 2011)
		11/100 mL	(July 2011)
		6/100 mL	(August 2011)
Site 5	:	8/100 mL	(January 2011)
		4/100 mL	(May 2011)
		4/100 mL	(September 2011)
Site 6	:	14/100 mL	(October 2010)
		8/100 mL	(November 2010)
		13/100 mL	(January 2011)
		6/100 mL	(February 2011)

About 30.7 percent drinking water samples collected had bacterial contamination and were found unfit for human consumption.

A monthly variation in the total coliform bacterial contamination in potable water samples from October 2010 to October 2011 is shown in Table 9.

## **Pesticides**

Pesticides are chemical used for controlling pests, unwanted species of plants, plant growth regulators etc. Due to leaching, they can enter our sources of water and contaminate them (Walker *et al.*, 1995).

Seventy eight drinking water samples collected from all the sites through out the year were investigated for the occurrence and content of pesticides viz. : Chlorobenzilate, Hexachloro-benzene, Benzenether, pp-DDT, op-DDT, pp-DDE, pp-DDD, alpha-HCH, Beta-HCH, Lindane, Vinclozolin, Conumaphos, Malathion, Phosalone, Cyfluthrin, Cypermethrin, Deltamethrin, Permethrin, Fenvalerate, Fluvalinate, Cyhalothrin, Carbofurn, Propoxeur, Carbaryl, Cymiazol, Amitraz, Bromprophylate, Chinomethionate. However, no drinking water samples tested negative for the presence of any of these pesticides i.e. no pesticides were present in the samples of potable water.

## **DISCUSSION**

### **Physico-Chemical Analysis**

- pH value determined for all the water samples collected from selected sites was found in the range of 6.73 to 7.77. All water samples were found to have pH within the limits of BIS / WHO i.e. 6.5 to 8.5.
- Dissolved Oxygen (DO) value is an indicative of pollution in water and depicts an inverse relationship with water temperature. The permissible limit for DO as per BIS / WHO is 6 mg/L. Drinking water samples collected from various sites of Noida were found to contain DO levels ranging from 1.70 mg/L to 6.26 mg/L. All drinking water samples had DO within BIS permissible limit.
- Total Dissolved Solids (TDS) content of the drinking water samples collected from various sites of Noida showed a range between 65 mg/L to 125 mg/L. However; all the water samples showed TDS value within BIS/WHO guidelines i.e. 500 mg/L.
- Total Hardness of water depicts the salt content present in it. The range of total hardness in all the drinking water samples was between 17 mg/L to 41 mg/L. However, all the water samples showed the range of hardness within permissible WHO/BIS (300 mg/L) limits.

### **Research Article**

- e. Alkalinity of the drinking water samples was within the range of 36 mg/L to 73 mg/L showing a comparatively large difference between the two values. All the water samples showed alkalinity within the limits as suggested by WHO/BIS (200 mg/L) guidelines.
- f. Fluoride levels ranging from 0.053 mg/L to 0.023 mg/L were detected in the drinking water samples. All drinking water samples had fluoride content within the range as suggested by WHO is 1.0 mg/L and as per BIS is 1.5 mg/L.
- g. Nitrates were present in all drinking water samples and the level ranged from 0.02 mg/L to 0.08 mg/L. All water samples had nitrate content within permitted BIS (45 mg/L), WHO (10 mg/L) permissible limit.
- h. Sulfate content in the drinking water samples ranged from 3.0 mg/L to 5.2 mg/L. All water samples contained sulfate content within the permissible limit as suggested by BIS / WHO i.e. 200 mg/L.

### **Bacteriological Analysis**

According to WHO and Bureau of India Standard (BIS) characteristics for drinking water (IS 10500: 1991), drinking water should contain "0" total coliform bacteria per 100 mL of water. The maximum permissible limit for fecal coliform is "0" per 100 mL of water. (MPN 0/100 mL). Bacteriological analysis of potable water sample of Noida did not have any fecal bacteria namely: *Escherichia coli* (*E.coli*), *Salmonella*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. However, contamination of total coliform bacteria was found in 30.7 percent tap water samples.

### **Pesticides**

Drinking water samples collected from various areas of Noida did not contain any pesticides. However, the standard for individual pesticides has been described at 0.001 mg/L and for total pesticides at 0.0005 mg/L as per BIS (IS 10500: 1991) guidelines. WHO has proposed guidelines for some pesticides, however there are no guidelines for majority of pesticides.

### **Conclusion**

Potable water samples collected from various areas of Noida City did not have any physico-chemical parameters and pesticides above BIS/WHO permissible limits. However, there was contamination of total coliform bacteria. Hence, some samples of water were found unfit for drinking purposes.

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