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*Research article*

# NITRATE, NITRITE, AMMONIUM AND PHOSPHATE IN VARIOUS DRINKING AND SURFACE WATERS SOURCES OF UTTAR PRADESH AND MADHYA PRADESH, INDIA

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**ABSTRACT:** An Investigation was carried out to study the level of some inorganic pollutant i.e. nitrate ($NO_3^-$), nitrite ($NO_2^-$), ammonium ($NH_4^+$) and phosphates ($PO_4^{3-}$) in surface and drinking water of U.P and M.P province. Nitrate level in all the surface water samples ranged between 4-25 mg $L^{-1}$. Only one site i.e. Nariwari Surval, showed $NO_3^-$ content 4 mg $L^{-1}$ which was below the Maximum Acceptable Limit (MAL) i.e. 13 mg $L^{-1}$. Nitrite was found 2-11 folds higher than the MAL (0.06 mg $L^{-1}$). Highest ammonium content was observed in Gomti river (3.20 mg $L^{-1}$) and lowest (0.29 mg $L^{-1}$) in Bihad river. However, $NH_4^+$ level in all the samples were below the MAL (5 mg $L^{-1}$). Phosphate content was more than their MAL (0.1 mg $L^{-1}$) in all the surface water samples. Their concentration varied from 1-3 mg $L^{-1}$ respectively. In drinking water samples $NO_3^-$ content ranged between 44-83 mg $L^{-1}$. All the samples contained $NO_3^-$ above the MAL (45 mg $L^{-1}$). Highest $NO_2^-$ content i.e. 4 mg $L^{-1}$ which was very close to the MAL (3.29 mg $L^{-1}$) was observed at Avadhesh Pratap Singh (A.P.S.) University and lowest i.e. 0.19 mg $L^{-1}$ at Lucknow University. Ammonium in all the samples was above the MAL (0.5 mg $L^{-1}$) however, highest value i.e. 6 mg $L^{-1}$ was detected at A.P.S. University. Phosphate was observed around 2 mg $L^{-1}$ in all the samples. Existing study revealed that water quality of all the sites of both the provinces is deteriorated.

**Keywords:** Inorganic pollutant, Surface water, Drinking water

## INTRODUCTION

Water quality assessment plays an important role to control the pollutant sources of water bodies for the implementation of sustainable water use [1]. Sewage pollution, drainage, livestock production and fertilizers are the sources of anthropogenic stress on the aquatic environment [2]. These activities pose threat to surface water bodies and also to ground water. Large proportion of nitrogen gets converted into nitrate ($NO_3^-$) which being soluble in water and not retained by soil and leached to the ground water table. Nitrate in drinking water is associated with a number of health problems such as BBS (Blue Baby Syndrome), cancer, Alzheimer's disease in humans, intestinal disorders in pigs, etc [3]. Nitrite ($NO_2^-$) has the ability to reacts with secondary amines present in human body and form carcinogenic nitrosamine [4]. Ammonium ($NH_4^+$) is a critical water quality parameter and reported toxic to the organisms. Symptoms of $NH_4^+$ poisoning are restlessness, dullness, weakness, muscle tremors profuse salivation, vocalization, lung edema, tonic-colonic convulsion, and finally death by heart failure [5]. Phosphate ($PO_4^{3-}$) at high concentration in surface water bodies accelerate the growth of microscopic (algae) to macroscopic (macrophytes) and excessive growth of these aquatic plants can causes eutrophication and this results in deficiency of dissolved oxygen (DO) which kills fishes and other aquatic fauna [6]. Toxicity of $PO_4^{3-}$ in humans includes impaired renal function, rhabdomyolysis and tumorolysis Syndrome [7]. Environmental monitoring agencies seem not to be too effective, so any abnormal change in water quality is not promptly recognized and dealt with, except when there is epidemic. This work is therefore aimed to study the level of some inorganic pollutants in surface and drinking water of Uttar Pradesh (U.P.) and Madhya Pradesh (M.P.).

## MATERIALS AND METHODS

**Sites:** Samples are collected during the summer season of 2010 and 11. Ten different sites were selected for sampling of surface and drinking water from U.P. and M.P. province, India. Sites description is presented in table 1 and 2

**Sampling and Analysis:** Six samples were collected from each site in well sterilize plastic bottles during the repeated years, 2010-2011. Nitrate was estimated by the method as described by [8], $NO_2^-$ by the method of [9] and $NH_4^+$ were assayed by Nessler's reagent method as described by [10]. Phosphate was determined by the stannous chloride method [11].AR grade reagents and double distilled water was used throughout the investigation.

## RESULTS AND DISCUSSION

**Surface Water:** Nitrate content in surface water samples of Gomti river, Lucknow, Jhalia,Vill., Bachharawan, Ganga River, Allahabad and Bihad River, Rewa was found in between 16-25 mg $L^{-1}$ which was 1-2 fold more than MAL i.e. 13 mg $L^{-1}$ [12]. Interestingly, one site Nariwari Surval showed very low content of $NO_3^-$ (4 mg $L^{-1}$). Ganga river at Allahabad had shown maximum $NO_3^-$ content that was 92.61% more, over the MAL (table 3). Nitrite ion concentration in all samples was in between 0.12-0.71 mg $L^{-1}$ that was 2-11 times more than MAL (0.06 mg $L^{-1}$) [13]. Highest $NO_2^-$ content i.e. 0.71 mg $L^{-1}$ was detected in Bihad river, Rewa and lowest in Gomti river, Lucknow (table 3). It shows that nitrifying bacteria are present in sufficient volume to maintain the balance of the entire nitrogenous ion present in water of Bihad river.Unlike $NO_3^-$ and $NO_2^-$, $NH_4^+$ content in all the surface water samples was surprisingly found below the MAL (5 mg $L^{-1}$) [12]. However, it ranged between 0.29-3.20 mg $L^{-1}$. Phosphate ions detected in samples were 18-28 fold more than MAL (0.1 mg $L^{-1}$) [14]. However, highly $PO_4^{3-}$ polluted site was Ganga river, Allahabad, having 3.91 mg $L^{-1}$ $PO_4^{3-}$ (table 3). This situation shows that the runoff from agricultural fields and sewage waste dispense the $PO_4^{3-}$ in high amount in Ganga River [15]. This problem is also found in Gomti river having $PO_4^{3-}$ level of 2.89 mg $L^{-1}$.

**Drinking Water:** Nitrate usually found in low quantities in surface water but may attain high levels in ground water. In water it is found in high content due to oxidation of $NH_4^+$ compounds [16]. Nitrate level in the drinking water samples from Lucknow University, Lucknow, Dhramsala, Kunda, Pratapgarh, J.P. Cement, Rewa and A.P.S. University was 33-86% higher than MAL i.e. 45 mg $L^{-1}$[17]. Only one site i.e. Tyodhara Teshil, Rewa showed $NO_3^-$ level of 44 mg $L^{-1}$ which was very close to the MAL value (table 4). Among all the sites investigated J.P. Cement, Rewa and A.P.S. University have $NO_2^-$ content around 4 mg $L^{-1}$ which was above the MAL (3.29 mg $L^{-1}$) [18] and rest of the sites showed its level below the MAL. However minimum content of $NO_2^-$ (0.19 mg $L^{-1}$) was noticed at Lucknow University, Lucknow (table 4). In the term of $NH_4^+$, all the samples collected from M.P. and U.P. province showed 5-12 times more $NH_4^+$ than MAL (0.5 mg $L^{-1}$) [12]. A.P.S. University water sample was found highly polluted with $NH_4^+$ (6.48 mg $L^{-1}$) whereas the lowest value was found at the Lucknow University, Lucknow i.e. 2.03 mg $L^{-1}$. All the samples revealed the $PO_4^{3-}$ content around 2 mg $L^{-1}$. Phosphate has no standards for drinking water [14].

**Table 1. Description of drinking water sampling sites**

| Sites | Place/State | Sample Source | Source of Pollutants |
|---|---|---|---|
| Lucknow University | Lucknow/U.P. | Bore well, 160-170 ft. depth | Daily waste |
| Thoyadhara Teshil | Rewa/M.P. | Hand pump, 50-55 ft. depth | Daily and Agri waste |
| Kunda Dhramshala | Pratapgarh/U.P. | Hand pump, 75-80 ft depth | Daily and Agri waste |
| J.P. Cement | Rewa/M.P. | Hand pump, 75-80 ft. depth. | Daily waste |
| A.P.S. University | Rewa/M.P. | Tap water | Daily waste |

**Table 2. Description of surface water sampling sites**

| Sites | Place/State | Sample Source | Source of Pollutants |
|---|---|---|---|
| Gomti River | Lucknow/U.P. | River Water | Sewage, Agri. and Industrial waste |
| Jhalia | Bachharawan/U.P. | Natural Pond | Urban and Agri. waste |
| Nariwari | Surval/U.P. | Natural Pond | Urban and Agri. waste |
| Ganga River | Allahabad/U.P. | River Water | City, Sewage, Agri. and Industrial waste |
| Bihad River | Rewa/M.P. | River Water | City, Sewage and Agri. waste |

**Table 3. $NO_3^-$, $NO_2^-$, $NH_4^+$ and $PO_4^{3-}$ concentration (mg $L^{-1}$) in the surface water samples collected from the States U.P. and M.P. during the year 2010-11**

| Sites | $NO_3^-$ | $NO_2^-$ | $NH_4^+$ | $PO_4^{3-}$ |
|---|---|---|---|---|
| Gomti River, Lucknow, U.P. | 22.04 ± 4.14 | 0.12 ± 0.02 | 3.20 ± 0.12 | 2.89 ± 0.14 |
| Jhalia,Vill., Bachharawan, U.P. | 16.81 ± 0.58 | 0.18 ± 0.01 | 0.61 ± 0.007 | 1.80 ± 0.05 |
| Nariwari, Surval, U.P. | 4.05 ± 0.20 | 0.20 ± 0.004 | 1.18 ± 0.03 | 3.88 ± 0.26 |
| Ganga River, Allahabad, U.P. | 25.04 ± 0.32 | 0.24 ± 0.02 | 1.63 ± 0.06 | 3.91 ± 0.22 |
| Bihad River, Rewa, M.P. | 18.91 ± 0.42 | 0.71 ± 0.02 | 0.29 ± 0.008 | 2.13 ± 0.4 |

Average values of 2010-11 ± S.D. (n=12)

**Table 4. $NO_3^-$, $NO_2^-$, $NH_4^+$ and $PO_4^{---}$ ions concentration (mg $L^{-1}$) in the drinking water samples collected from the States U.P. and M.P. during the year 2010-11**

| Sites | $NO_3^-$ | $NO_2^-$ | $NH_4^+$ | $PO_4^{3-}$ |
|---|---|---|---|---|
| Lucknow,University, Lucknow, U.P. | 60.11±21.53 | 0.19 ± 0.03 | 2.83 ± 0.31 | 2.03 ± 0.08 |
| Tyodhara Teshil, Rewa, M.P. | 44.28 ± 2.46 | 2.35 ± 0.01 | 4.19 ± 0.15 | 2.27 ± 0.19 |
| Dharamsala,Kunda, Pratapgarh, U.P. | 78.31 ± 3.81 | 3.06± 0.002 | 4.6 ± 0.001 | 2.20 ± 0.12 |
| J.P. Cement, Rewa, M.P. | 77.21 ± 2.70 | 4.08± 0.003 | 4.99 ± 0.02 | 2.68 ± 0.04 |
| A.P.S. University, M.P. | 83.74 ± 3.02 | 4.56 ± 0.03 | 6.48 ± 0.48 | 2.13 ± 0.09 |

Average values of 2010-11 ± S.D. (n=12)

## CONCLUSION AND RECOMMENDATION

The results of the study revealed that surface water of U.P. is severely polluted with the inorganic pollutants than that of M.P. But it also concludes that water qualities of both the provinces are seriously deteriorated by inorganic pollutant which is dangerous for the existence of water bodies' natural ecosystem. The same results are concluded in the terms of drinking water too. Hence, some major steps are required for the remediation of ground water pollution as well as to sustain fresh water supply from the surface water bodies for the mankind and sustainable development. Therefore, near potential point sources of contamination, such as livestock facilities or sewage disposal areas, should be tested timely to monitor the changes in the concentration of inorganic pollutants.

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