



STUDY OF NITRATE IN GROUND WATER OF JHUNJHUNU DISTRICT OF RAJASTHAN: A CAUSATIVE AGENT OF METHEMOGLOBINEMIA

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ABSTRACT

A survey was conducted in 136 villages during Jan. 2009 to Jan. 2012 in Jhunjhunu district, Rajasthan. It was found that 152 patients (mostly bottle fed infants) were suffering from methemoglobinemia (Blue baby syndrome). Methemoglobinemia is caused by the decreased ability of blood to carry vital oxygen around the body. One of the most common cause is the presence of nitrate in high concentration in drinking water. Children show signs of blueness around the mouth, hands and feet. For the analysis, 269 water samples were collected from 136 villages. Analysis of nitrate was done by spectrophotometric method. The maximum permissible limit of nitrate in drinking water is 45 ppm according to ISI and WHO. The concentration of nitrate was found in the range of 10-180 ppm. Such high concentration of nitrate is responsible for methemoglobinemia.

Key words: Nitrate, Toxicity, Analysis, Methemoglobinemia.

INTRODUCTION

Present study is related with Jhunjhunu district of Rajasthan, where blue baby syndrome or methemoglobinemia is a common occurring disease in local population. One of the most common cause is the presence of nitrate in high concentration in drinking water.

Nitrate (NO_3^-) is a naturally occurring form of nitrogen found in soil. Nitrogen is essential to all life. Most crop plants require large quantities to sustain high yields. The formation of nitrates is an integral part of the nitrogen cycle in our environment. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements and may accumulate nitrate in their leaves and stems. Due to its high mobility, nitrate can also leach into groundwater. If human beings or animals drink

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water with high nitrate concentration, it may cause methemoglobinemia, an illness found especially in infants¹.

Nitrates are formed, when microorganisms break down fertilizers, decaying plants, manures or other organic residues. Usually plants take up these nitrates. But sometimes rain or irrigation water can leach them into groundwater. Although nitrate occurs naturally in some groundwater, in most cases, higher levels are thought to result from human activities. Common sources of nitrate include fertilizers and manure, animal feedlots, municipal wastewater and sludge, septic systems, and N-fixation from atmosphere by legumes, bacteria and lightning².

EXPERIMENTAL

A survey was conducted in 136 villages during Jan. 2009 to Jan. 2012 in Jhunjhunu district, Rajasthan. For the analysis, Jhunjhunu district is divided into 38 Gram panchayat of Jhunjhunu block. Samples were collected from tubewell and hand pumps present in this area. In laboratory, nitrate is determined by spectroscopic method as follows :

Nitrate was determined spectrophotometrically by using UV-Visible Spectrophotometer (Model No. 301) at single wavelength of 220 nm. It follows the Lambert-Beer's law up to nitrate concentration of 11 mg/L. Water sample was acidified with 1 N HCl to prevent interferences of hydroxides or carbonate concentration up to 100 mg./l. as CaCO_3 .^{3,4}

RESULTS AND DISCUSSION

The maximum permissible limit of nitrate in drinking water is 45 ppm according to ISI and WHO. Investigations show that nitrate level ranges from 10-180 ppm.

Such high nitrate levels in water is responsible for methemoglobinemia or blue baby syndrome, a condition found especially in infants under six months. It was found that 152 patients (mostly bottle fed infants) suffer from blue baby syndrome. Methemoglobinemia is caused by the decreased ability of blood to carry vital oxygen around the body. The stomach acid of an infant is not as strong as in older children and adults. This causes an increase in bacteria that can readily convert nitrate into nitrite⁵.

Nitrite is absorbed in the blood and hemoglobin (the oxygen carrying component of blood) is converted to methemoglobin. Methemoglobin does not carry oxygen efficiently. This results in a reduced oxygen supply to vital tissues such as the brain. Methemoglobin in

blood of infant cannot change back to hemoglobin, which normally occurs in adults. Severe methemoglobinemia can result in brain damage and death⁶.

| Nitrate concentration analysis of ground water | | | | |
|---|------------------------|-----------------------|-----------------------------|-----------------------|
| S. No. | Source | Gram Panchayat | Total no. of samples | NO₃ |
| 1 | Open well | Bishanapura | 8 | 10-70 |
| 2 | Open well hand pump | Siriyasar Kalan | 8 | 55-95 |
| 3 | Open well hand pump | Abusar | 9 | 75-180 |
| 4 | Open well hand pump | Derwala | 11 | 25-100 |
| 5 | Open well hand pump | Hanumanpura | 7 | 35-115 |
| 6 | Open well hand pump | Kuhadu | 5 | 50-140 |
| 7 | Open well hand pump | Wahidpura | 6 | 60-75 |
| 8 | Open well hand pump | Meharadasi | 7 | 45-170 |
| 9 | Open well hand pump | Bheemsar | 6 | 55-105 |
| 10 | Open well hand pump | Nua | 7 | 35-60 |
| 11 | Open well hand pump | Bahadurwas | 8 | 40-110 |
| 12 | Open well hand pump | Chatarpura | 9 | 60-85 |
| 13 | Open well hand pump | Bakra | 8 | 40-65 |
| 14 | Open well hand pump | Budana | 10 | 55-130 |
| 15 | Open well hand pump | Ajari Kalan | 5 | 30-65 |

Cont...

| Nitrate concentration analysis of ground water | | | | |
|---|---------------------|-----------------------|-----------------------------|-----------------------|
| S. No. | Source | Gram Panchayat | Total no. of samples | NO₃ |
| 16 | Open well hand pump | Beebasar | 8 | 30-65 |
| 17 | Open well hand pump | Bas Nanag | 6 | 40-60 |
| 18 | Open well hand pump | Sigra | 6 | 40-50 |
| 19 | Open well hand pump | Bharunda Khurd | 10 | 35-70 |
| 20 | Open well hand pump | Indali | 5 | 45-65 |
| 21 | Open well hand pump | Kulod Kalan | 14 | 45-120 |
| 22 | Open well hand pump | Patusari | 8 | 55-85 |
| 23 | Open well hand pump | Purohito ki Dhani | 7 | 30-85 |
| 24 | Open well hand pump | Islampur | 5 | 20-30 |
| 25 | Open well hand pump | Makhar | 6 | 25-65 |
| 26 | Open well hand pump | Jai Pahari | 4 | 45-80 |
| 27 | Open well hand pump | Bhojasar | 4 | 20-35 |
| 28 | Open well hand pump | Shekhsar | 7 | 55-70 |
| 29 | Open well hand pump | Bharu | 7 | 35-55 |
| 30 | Open well hand pump | Nayasar | 5 | 65-120 |
| 31 | Open well hand pump | Partappura | 11 | 45-55 |

Cont...

| S. No. | Nitrate concentration analysis of ground water | | | |
|--------|--|----------------|----------------------|-----------------|
| | Source | Gram Panchayat | Total no. of samples | NO ₃ |
| 32 | Open well hand pump | Kasimpura | 7 | 50-150 |
| 33 | Open well hand pump | Lalpur | 7 | 60-70 |
| 34 | Open well hand pump | Khajpur naya | 6 | 55-95 |
| 35 | Open well hand pump | Udawas | 10 | 45-160 |
| 36 | Open well hand pump | Bagar | 3 | 45-80 |
| 37 | Open well hand pump | Kishorepura | 5 | 40-75 |
| 38 | Open well hand pump | Solana | 4 | 20-30 |

Pregnant women, adults with reduced stomach acidity and people deficient in the enzyme that changes methemoglobin back to normal hemoglobin are all susceptible to nitrate induced methemoglobinemia. The most obvious symptom of methemoglobinemia is the bluish colour of the skin, particularly around the eyes and mouth. Other symptoms include headache, dizziness, weakness or difficulty in breathing⁷.

Healthy adults can consume fairly large amounts of nitrate with few known health effects. In fact, most of the nitrate we consume is from our diets, particularly from raw or cooked vegetables. This nitrate is readily absorbed and excreted in the urine. However, prolonged intake of high levels of nitrate are linked to gastric problems due to the formation of nitrosamines. N-nitrosamine compounds have been known to cause cancer.

Exposure to higher levels of nitrate has been associated with increased incidence of cancer in adults and possible increased incidence of brain tumors, leukemia and nasopharyngeal tumor⁸.

CONCLUSION

Methemoglobinemia disease spreading in this area is due to increased uptake of nitrate or nitrite from drinking water. Jhunjhunu block of Jhunjhunu district, Rajasthan has limited uncontaminated water supplies. So water borne diseases is a huge health issue.

REFERENCES

1. P. N. Soltanpour, I. Broner and R. H. Follett, Nitrogen and Irrigation Management, 0.514 (1999).
2. L. Fewtrell, D. Kay and A. Godfree, The Microbiological Quality of Private Water Supplies, J. Chartered. Inst. Water Environ. Manag., **12**, 98-100 (1998).
3. J. R. Self and P. N. Soltanpour, Soil Sampling, 0.500 (1997).
4. A. A. Avery, Infantile Methemoglobinemia: Reexamining the Role of Drinking Water Nitrates, Environ. Health Perspect, **107**, 583-586 (1999).
5. P. N. Soltanpour and W. L. Raley, Livestock Drinking Water Quality, 4.908 (1993).
6. J. R. Self, Domestic Water Quality Criteria, 0.513 (1998).
7. Kendall, P., Drinking Water Quality. 9.307 (1992).
8. T. L. Stanton, Nitrate Poisoning, 1.610 (1992).

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