LEVEL OF NITRATE AND NITRITE CONTENTS IN DRINKING WATER OF SELECTED SAMPLES RECEIVED AT AFPGMI, RAWALPINDI

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Background: Contamination of drinking water by nitrates is an evolving public health concern since nitrate can undergo endogenous reduction to nitrite and nitrosation of nitrites can form N-nitroso compounds, which are potent carcinogens. The carcinogenic feature of N-nitroso compounds has been well established. Nitrites can lead among infants to the disease called methemoglobinemia (blue baby syndrome). There is a strong relationship between nitrate concentration and recurrent diarrhoea and also other illnesses. The aim of this study was to evaluate the level of nitrate and nitrite contents in some drinking water samples. **Methods:** In this study we analysed 162 water samples received at Water Quality Control Laboratory, AFPGMI, Rawalpindi for their nitrate and nitrite contents. **Results:** Out of these 162 water samples, 153 (94%) and 133 (82%) samples had nitrate and nitrite contents in varying concentrations, while 64 (40%) and 22 (14%) had nitrate and nitrite concentrations more than Pakistani standards. **Conclusions:** Given the potential health risk associated with the presence of toxicants like nitrates and nitrites in water sources used for drinking yet the scarcity of available data, there is a need to evaluate these waters and develop strategies to reduce and prevent their contamination.

Keywords: Nitrate, Nitrite, Drinking Water

INTRODUCTION

As the whole human population needs drinking water for sustaining life the provision of a safe water supply is a high priority issue for safeguarding the health and well-being of humans. The production of adequate and safe drinking water is the most important factor contributing to a decrease in mortality and morbidity in developing countries.

The World Health Organization (WHO) reported that nearly half of the population in these countries suffers from health problems associated with lack of drinking water or the presence of microbiologically contaminated water.[1] In the developing countries more than 60 percent population has no access to pure drinking water.[2] The basic question in the production of drinking water is how to rid drinking water of potentially dangerous microorganisms and chemical without introducing new hazards that might pose new and different threats to human health. Water treatment and distribution system, if not properly operated and maintained can be a source of disease outbreak affecting large populations. Therefore, the monitoring and surveillance of quality of raw water sources as well as treated water need to be enhanced.[3]

Water is a very good solvent, hence it dissolves some toxic and hazardous substances, producing water pollution problem posing many public parameters of interest for water quality assessment and nitrates and nitrites are out of them. Furthermore, turbidity and nitrate concentrations peak during heavy rain episodes.[4].

An increase of nitrates in water is often associated with farming fertilizer, pesticide or poor sanitary activities.[5-9] The WHO guideline for nitrates in drinking water is established to prevent methaemoglobinaemia (blue babies), which is lethal in babies and can be potentially hazardous with health risks for considerable groups of people and depends on the conversion of nitrates to nitrites and wells which were shallow, dug of located on large farms, or springs were more likely to have elevated concentrations of nitrates.[10-14] The use of nitrate-contaminated drinking water to prepare infant formula is a well-known risk factor for infant methaemoglobinaemia. Affected infants develop a peculiar blue-grey skin color and may become irritable or lethargic depending on the severity of their condition. The condition can progress rapidly to cause coma and death if it is not recognized and treated appropriately.[15] Contamination of drinking water by nitrates is an evolving public health concern since nitrates can undergo endogenous reduction to nitrites (nitrate (III)), and nitrosation of nitrites can form *N*-nitrose compounds, which are potent carcinogens. This reduction process runs relatively fast in the alimentary canal of infants under the age of 6 months, so can lead among infants to the disease called methemoglobinemia (blue baby syndrome).[16] There is a positive association between nitrates in drinking water and non-Hodgkin lymphoma and colorectal cancer.[17] In 1986 WHO fixed the limit of the contents of nitrates and nitrites in drinking water, taking guidance from which Pakistani standards were developed. According to Pakistan Standards,[18] fixed limits of the contents of nitrates and nitrites in drinking water are to 10 mg NO_3-/litre and 0.020 mg NO_2-/litre.

MATERIAL AND METHODS

We analysed 162 water samples received at Water Quality Control Laboratory. AFPGMI, Rawalpindi for their nitrate and nitrite contents. Out of them, ninety one samples were from twin cities i.e Rawalpindi and Islamabad and most of them were ground waters. All the procedures carried out for the examination of water samples were according to Standard Methods for the Examination of Water and Wastewater[19-20] and Examination of Water for Population Control (WHO) and guidelines for drinking water quality.[21-22]

Table-1: Methods and their references.

Element	Method	Ref. Method Number	
		APHA, 1998, 1995	WHO, 1982
Nitrite	Colorimeter method using Sulfanilic acid & a-napthylamine	4500-NO_2	15.4
Nitrate	Colorimeter method using Phenol disulphonic acid	4500-NO_3	15.3.5.5

RESULTS

Nirates were found in most of the water samples ranging from traces to the maximum of 1125 mg/litre (Haripur well water) (Table-2. Fig-2). Out of 162 water samples, ninety one samples were from twin cities i.e. Rawalpindi and Islamabad and most of them were ground waters. Out of these 162 water samples, 153 (94%) and 1333 (82%) samples had nitrate and nitrite contents in varying concentrations respectively, while 64 (40%) and 22 (14%) had nitrate and nitrite concentration more than Pakistani standards respectively. Nine and twenty-nine samples had nil value of nitrates and nitrates respectively (Table & Fig. 1 & 2). To obtain an indication of the nitrate-nitrogen levels in drinking water in rural areas of upstate New York and the number of infants at risk for methaemoglobinemia, 419 wells supplying drinking water to farms were tested by Gelberg et al.[13] Overall, nitrates were detectable in 95% of the wells tested (concentration levels greater than 0.05 mg/litre) ad 15.6 % had levels which exceeded 10 mg/litre (45 mg/litre NO_3). Fifteen percent of the wells tested from farms where infants resided were also elevated. Wells, which were shallow, dug or located on large farms, or springs were more likely to have elevated concentrations of nitrates.

DISCUSSION

The toxicity of nitrate to humans is thought to be solely the consequences of its reduction to nitrite.[17] In these samples, nitrate levels were ranged from 0 to 1125 mg/litre showing a great variety with a mean of 20 mg/litre showing a great variety with a mean of 20 mg/litre. Nitrates and nitrites are indicators of remote and recent faecal pollution respectively. The results of investigations of Yang et al.[23] showed that there is a significant positive association between drinking water nitrate exposure and gastric cancer mortality. In a study conducted in California an association between maternal preconceptional exposure to nitrate from drinking water and an elevated risk for anencephaly was found.[24] An earlier Australian study also indicated an association between neural tube defects and nitrate.[25]

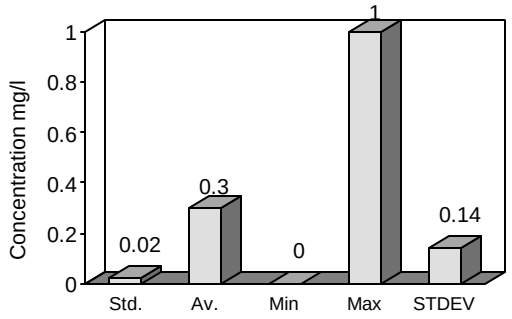

Fig. 1: Graphical representation of the concentration of Nitrates in drinking water samples.

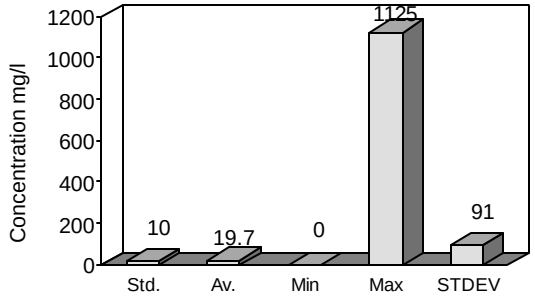

Fig-2: Graphical representation of the concentration of Nitrites in drinking water samples.

Nitrate is used mainly in inorganic fertilizers.[22,26] Generally the nitrate concentration in our water samples reaches high levels as a result of agricultural runoff, refuse dump runoff or contamination with human or animal waste.[6,8] In contrast to surface waters, nitrate levels exceeded 10 mg/litre in many of our ground water samples. A similar situation was observed in USA in 1986, when greater number of ground waters showed higher concentrations of

nitrate than the surface waters.[22] Moreover individual wells could have significantly higher concentrations.[13]

Ezeonu et al.[27] suggested that nitrate in drinking water probably plays an important role in gastric carcinogenesis. According to Johnson and Kross,[28] infant illness and death from nitrate-induced methaemoglobinemia is probably often misdiagnosed perhaps as sudden infant death syndrome and certainly ocntributes to the national infant death rate statistic. A 1950 report listed 144 cases of infant methaemoglobinemia with 14 deaths in one 30 months period in Minnesota. Infant deaths resulting from misdiagnoses of this preventable, treatable intoxication were still occurring in 1986 in South Dakota. In this state about 39% of dug or bored well were unsafe due to high nitrate content, compared with 22% of drilled wells and 16% of driven wells. In Pakistan, the population constitutes mostly of the low-income class, which cannot afford bottled water from markets especially for infants and for immunocompromised or immunosuppressed patients but again, most of the bottled water from markets are also not safe.

According to Gupta et al.[29] a review of the literature indicated an association among high nitrate ingestion, methaemogloinemia and pathologic changes in bronchi and lung parenchyma. They observed strong interdependence between methaemoglobin levels and RRTI in children upto 8 years of age. That study indicated that methaemoglobinemia, secondary to high nitrate ingestion in drinking water, causes RRTI. Increased production of methaemoglobin and free radicals of nitric oxide and oxygen due to nitrate metabolism in the body lead to alveolar damage and mismatching of ventilation and perfusion, which may be the reason for high mortality in children due to RRTI. There was a strong relationship between nitrate concentration and recurrent diarrhoea; 80% of the recurrent diarrhoea cases were explained by nitrate concentration alone.[30]

According to Gatseva and Dimitrov[31] the population morbidity was studied in the village Karadzhalovo, the district of Plovdiv, where concentration of nitrates in drinking water was constantly above the tolerable limit. Reid et al.[32] analysed the quality of drinking water from private water supplies in Aberdeen shire, UK with respect to the presence of total coliforms (total coliform), faecal coliforms (faecal coliform) and nitrate. The results suggested that it was the groundwater source itself that contributed much of the microbiological and nitrate contamination rather than a storage or supply line contamination mechanism. Significant positive relationship with rainfall amount was also important. Pakistan is faced with a serious problem of potable water supply in its urban areas e.g Islamabad, Karachi and Quetta etc. The situation is even worst in villages, which lack public water distribution system. The underground water in Karachi has also become quite unsafe due to mixing of sanitary and sewage systems. About 900 out of 1100 water samples collected from different pipelines and hotels and tested by Karachi Metropolitan Corporation laboratory were found unfit for human consumption. Those consuming such are vulnerable to gastrointestinal troubles, diarrhoea and other abdominal ailments.[33]

D'Auriac et al.[34] emphasizes that the hygienic quality of water is of utmost importance to the society. Given the potential health risk associated with the presence of toxicants like nitrates and nitrites in water sources used for drinking yet the scarcity of available data, there is a need to evaluate these waters and develop strategies to reduce and prevent their contamination.

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