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RESEARCH ARTICLE

DETERMINATION OF NITRATE IN GROUNDWATER OF PRODDATUR, MYDUKUR AND YERRAGUNTLA AREAS OF YSR KADAPA DT., (AP) INDIA

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ABSTRACT

Nitrate contamination in groundwater is a common problem in many parts of the world. Nitrate is a common nitrogenous compound due to natural processes of the nitrogen cycle, igneous rocks, anthropogenic sources like unsecured septic tanks, application of nitrogen-rich fertilizers in agricultural processes. The level of nitrate concentration in groundwater of three densely populated areas, Proddatur (PDTR), Mydukur (MYD) and Yerraguntla (YGL) of YSR Kadapa district was evaluated. A total of 30 samples from tube wells were collected and analyzed for nitrate using UV-VIS spectrophotometer. The average groundwater nitrate concentrations of the study areas are reported as 112.7 mg/L for PDTR, 41.3 mg/L for MYD and 120.82 mg/L for YGL area. The nitrate concentration in 63 % samples of the study area exceeded the maximum permissible limit of nitrate (45 mg/L) for drinking water set by WHO and thus pose a threat to human health. The consumption of nitrate rich water causes a large number of diseases like dizziness, abdominal disorder, vomiting, weaknesses, mental disorder and even stomach cancer and blue baby syndrome or methemoglobinemia which robs the blood cells of their ability to carry oxygen. Due to the detrimental biological effects, treatment and prevention methods must be considered to protect groundwater aquifers from nitrate leaching and high concentrations.

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INTRODUCTION

Nitrogen is the most abundant element in the atmosphere; comprising nearly 78% of the air we breathe (Berner and Berner, 1987). Nitrogen is a major constituent of the earth's atmosphere and occurs in many different gaseous forms such as elemental nitrogen, nitrate and ammonia. Natural reactions of atmospheric forms of nitrogen with rainwater result in the formation of nitrate and ammonium ions. Gaseous nitrogen can be found in many forms, the major ones consisting of N_2, N_2O, NO, NO_2, NH_3. Some of these gases readily react with rain water to produce nitrate and ammonium ions in solution. These ions can become part of the soil layer composition, or even enter into a groundwater solution. Various factors are involved in natural contamination of ground water, which may include the nature and thickness of surface deposits, rainfall quantity, and distribution, depth to the groundwater level, distribution of vegetation types and presence of nitrogen-fixing vegetation. High levels of natural nitrate only occur in groundwater. Although geologic units can contribute nitrate to ground water, sources of nitrogen generally occur at the land surface (Boyce *et al.*, 1976). Humans have altered the nitrogen cycle dramatically over the last half-century, and as a result, nitrate is steadily accumulating in our water resources. Globally, human nitrogen production has increased rapidly since 1950 and currently exceeds nitrogen fixed by natural sources by about 30% (Fields, 2004).The manufacture of nitrogen-containing fertilizer for food production and the cultivation of leguminous crops convert atmospheric N_2 into reactive forms that significantly perturb the global nitrogen cycle and threaten the stability of the planet (Mac Quarrie *et al.*, 2001; Carey and Lloyd, 1998; Buda *et al.*, 2014). Nitrates in groundwater could occur by the leaching of fertilizers from soil during surface runoff and also nitrification of organic matter (Thompson, 1986; Madison, 1984; Spalding, 1993). Although there are many sources of nitrogen, both natural and anthropogenic, that could potentially lead to the pollution of the groundwater with nitrates, the anthropogenic sources are really the ones that most

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often cause the amount of nitrate to rise to a dangerous level. Waste materials are one of the anthropogenic sources of nitrate contamination of groundwater. Many local sources of potential nitrate contamination of groundwater exist such as, sites used for disposal of human and animal sewage (Ako *et al*., 2011); industrial wastes related to food processing, munitions, and some poly resin facilities; and sites where handling and accidental spills of nitrogenous materials may accumulate (Hallberg, 1993). Ground water contamination is usually related to the density of septic systems. In densely populated areas, septic systems can represent a major local source of nitrate to the groundwater. However in less populated areas septic systems don't really pose much threat to groundwater contamination.

Nitrogen pollution from intensive agriculture not only affects the environment, but may also affect human health (Chetna Sharma *et al*., 2016). The presence of nitrogen containing particles in the atmosphere may give rise to respiratory health problems. The consumption of nitrate rich water causes a large number of diseases like dizziness, abdominal disorder, vomiting, weaknesses, alzheimer's disease, mental disorder and even stomach cancer (Perlistein, 1976; Thind, 1982; Burt, 1993; van Grinsven, *et al*., 2010; Erisman, 2011; Priyamithra Minoth, 2015). Exposure to nitrate concentrations over the 10 mg/L is associated with a condition called methaemoglobenemia or blue- baby syndrome in infants six months of age and younger (Hem, 1989). Nitrate in drinking water is converted to nitrite in the baby's stomach. Nitrite changes hemoglobin to methemoglobin which is unable to bind with oxygen, thus depriving the cells of oxygen and hence no relaxation is provided beyond 45mg/l of nitrogen in the BIS Standards even under conditions of no alternate source of drinking water. In extreme cases it can cause death also. Excess of nitrate also causes degradation of the local ecosystems like excessive plant and algal growth (Murgulet and Tick, 2008).

The YSR Kadapa district under lied by various rock types of different age groups from archaen to recent. The major rock types are quartzites, shales, limestone, phyllites, granites, granodiorites, granite gneiss and magmatites. Black soils are generally associated with clay content are located in Proddatur, Mydukur and Yerraguntla areas. Groundnut, black gram, red gram, bengal gram, paddy are major agricultural crops in the study area. The pre-dominant crop is rain fed groundnut which accounts for 52% of the annual cropped area. So, there is a possibility for leaching of nitrate into groundwater due to these leguminous crops, dyeing industries and various rock types. On thorough literature survey it was observed that no reports are available on nitrate level in groundwater of the study area which prompted us to take up this study.

MATERIALS AND METHODS

Study area

PDTR (Figure-b) is the second largest municipal town of YSR Kadapa district in Andhra Pradesh (Figure-a), India, which lies between 14°73^{l} North latitude and 78^{o}55^{l} East longitude respectively. The area of the town is 7.125 square kilometers with an elevation of 158 meters. As per 2011 census, the town had a population of 1, 62,816 with a population density of 23000 inhabitants per square kilometer. Dyeing is one of the major activities in this area. MYD Municipal Town (Figure-c) in YSR Kadapa district is located is located at a latitude of 14.72N and longitude of 78.73E. As per 2011 census, the town had a population of 39,941.YGL municipal town in YSR Kadapa district (Figure-d) is located in Andhra Pradesh (Figure-1(a))**.** The area is located at 14.63N and 78.53E coordinates with an elevation of 152 meters. As per 2011 census, the town had a population of 32,574. The study area is dominantly an arenaceous consisting of conglomerate quartzite, Quartzite with shale formation of dolomitic lime stones.

Sample collection

A total of 30 ground water samples were collected randomly from the study area in 1 L plastic bottles previously and scrupulously cleaned with non-ionic detergent, rinsed with tap water and finally with distilled, de-ionized water.

Methodology

Nitrate level in the ground water can be analyzed by using phenol disulphonic acid method (Jagessar and Sooknundun, 2011), Spectrophotometric method (Baezzat *et al*., 2011; Verma *et al.,* 2014), colorimetric method, ion selective electrode method (Girma *et al*., 2015), ion-liquid chromatography (Damien Connolly and Brett paull, 2001) and capillary electrophoresis method (Eva Martinkova *et al.*, 2014). Nitrate level in the present study was analyzed by using Spectronics-2080 double beam UV-VIS spectrophotometer with spectral band width of 0.1nm and a pair of 10 mm quartz cells for all absorbance measurements. Ultraviolet and visible (UV-Vis) absorption spectroscopy was the measurement of the attenuation of a beam of light after it passes through a sample or after reflection from a sample surface.

The selected method for present study is based upon the reaction of the nitrate ion with brucine sulphate which produces yellow coloured complex. The intensity of the resulting complex was measured at 410 nm. The nitrate concentration of ground water samples was determined from a standard curve obtained by plotting the absorbance of standards against nitrate concentration (mg/L).

Reagents and solutions

All chemicals used were of analytical grade unless otherwise specified. All water used was milli-Q water obtained from Millipore water purification system. Brucine- Sulphanilic acid reagent was prepared by dissolving 1gm of brucine sulphate $[(C_{23}H_{26}N_2O_4)_2\ H_2SO_4\ 7H_2O]$ and 0.1 g sulphanilic acid ($NH_2C_6H_4SO_3H.\ H_2O$) in 70 mL hot distilled water. To this 3 mL of conc. HCl was added, cooled, mixed and diluted to 100 mL with distilled water. Potassium nitrate stock solution was prepared by dissolving 0.7218 g anhydrous potassium nitrate (KNO_3) in distilled water and diluted to 1 liter.30% NaCl solution was prepared by dissolving 30gm of NaCl in 100 mL distilled water.13N H_2SO_4 was prepared by the addition of 500mL Conc. H_2SO_4 to 125 mL of distilled water.

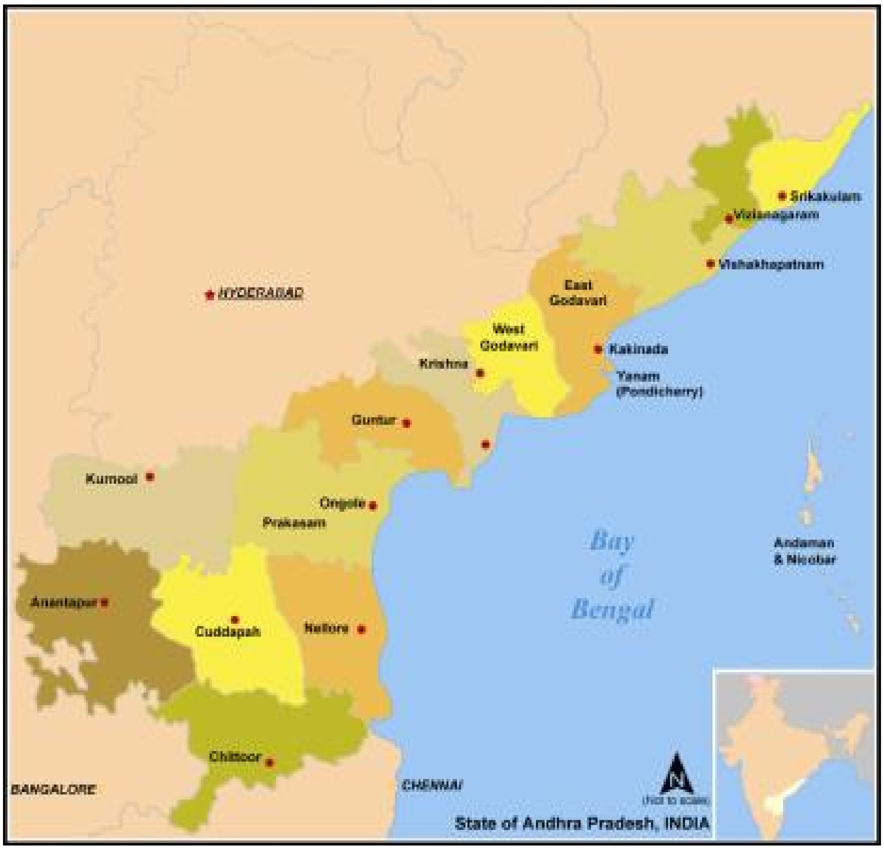

Fig.a-Andhra Pradesh

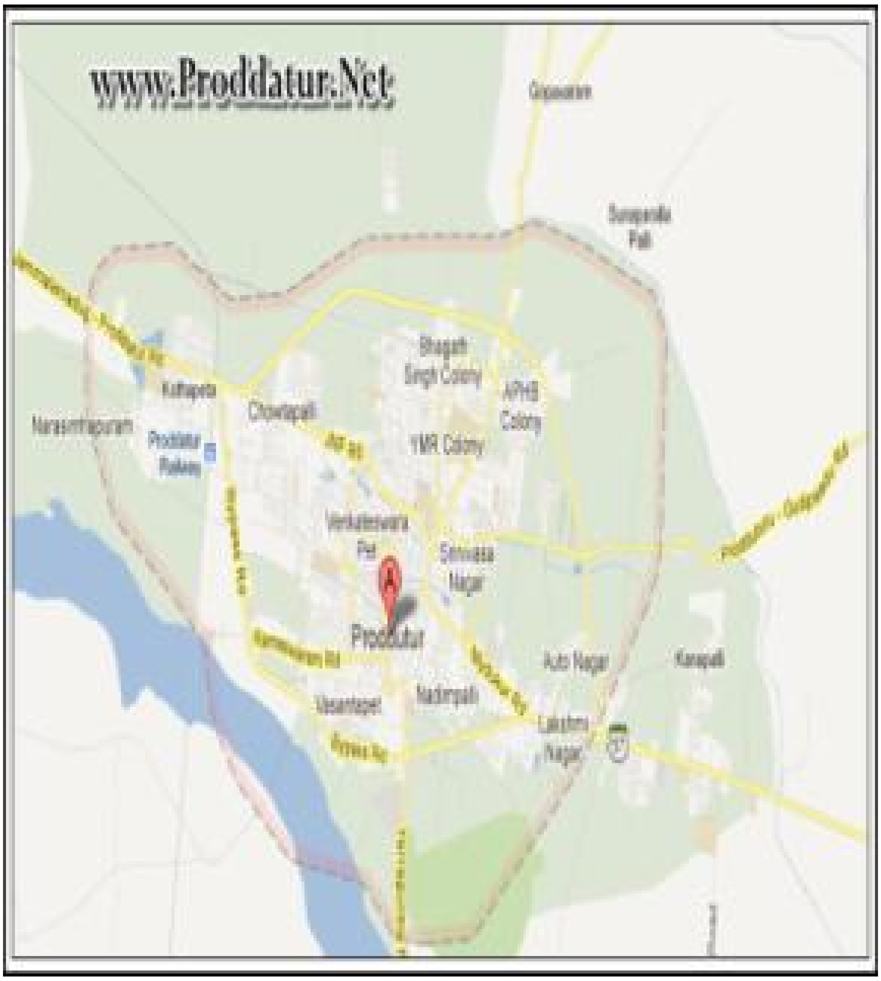

Figure -b-PDTR

Figure-c-MYD

Figure-d-YGL

Table 1. Nitrate concentration in the study area

PDTR			MYD			YGL		
S. NO.	Location	Nitrate (mg/L)	S. NO.	Location	Nitrate (mg/L)	S. NO.	Location	Nitrate (mg/L)
1	Modampalle	169	11	Sarvayapalle	61	21	Vempalle road	158
2	SastryNagar	119	12	Saibaba Temple	23	22	Saibaba Temple	129
3	Industrial area	13	13	PML road	13	23	TTD Mandapam	0.2
4	YMR Colony	209	14	Nandyal road	41	24	Mahesh nagar	106
5	HB Colony	152	15	Sainadhpuram	52	25	VNPPetrol bunk	124
6	Bollaram	82	16	SBSN College	5	26	Bajaj Showroom	139
7	Rameswaram	202	17	PDTR road Rice mill	45	27	Yadamagudi	26
8	One Town	162	18	B.C.Hostel	40	28	Shadi khana	79
9	Two Taps	6	19	SaradaHigh school	86	29	Chowdamma Temple	259
10	Dorasanipalle	13	20	PDTRroad watersupplier	47	30	Rly Station	188

Table 2. Statistical comparison of Nitrate concentration in the study area

Nitrate conc.(mg/L)	PDTR	MYD	YGL
Minimum	6	5	0.2
Maximum	209	86	259
Average	112.7	41.3	120.82
Median	135.5	43	126.5
SD	79.33	23.57	75.20
Skewness	-0.3509	0.2310	0.1030
Kurtosis	-1.6057	0.3572	0.3174
WHO permissible limit	45	45	45
Percentage of samples exceeding WHO limit	70	40	80

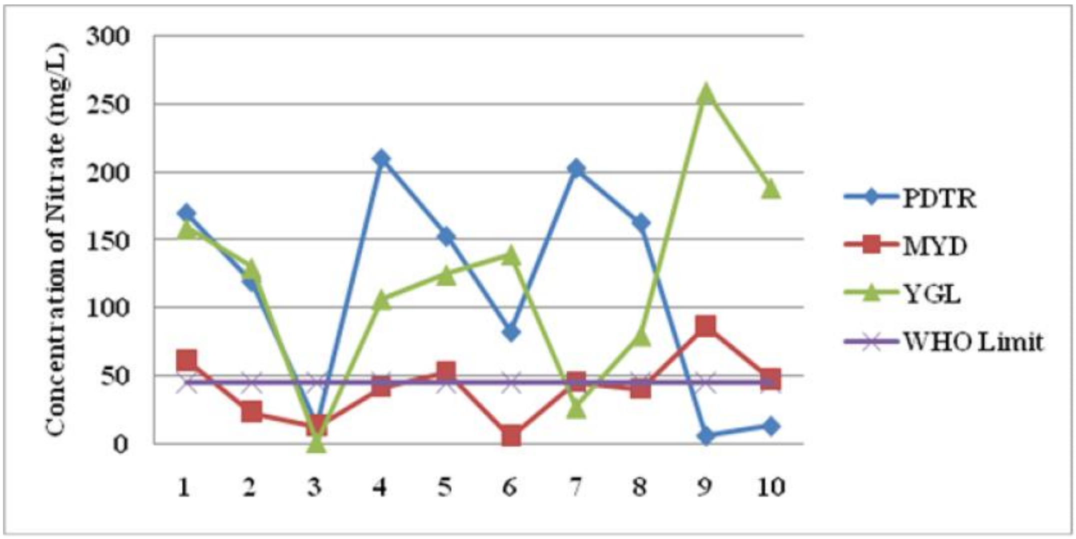

Figure-e Comparison of nitrate concentration in the study area

RESULTS AND DISCUSSION

In the present study, a total of 30 samples were collected and analyzed for nitrate concentration in drinking water. The results showed that the nitrate concentration in the groundwater samples ranged from 0.2 to 259 mg/L (Table-1). According to WHO, the maximum permissible limit of nitrate in drinking water is 45 mg/L. Of the total 30 groundwater samples analyzed, 70% of the samples in PDTR area, 40% of samples in MYD area and 80% of samples of YGL area (Figure-e), had high nitrate concentration than the prescribed value (Table-2).Overall, 63% of samples in the study area contain excess of nitrate concentration than the maximum permissible limit set by WHO which arises a serious concern over health related issues of the local population.

Only 37% of samples in the study area are suitable for drinking in terms of nitrate concentration. As agriculture and dyeing are main activities of this region, a considerable portion of applied agrochemicals and dyes are expected to penetrate the soil and reach the groundwater table. This is likely to increase the nitrate concentration in groundwater.

Conclusion

A total of 30 ground water samples were collected and analyzed for nitrate level determination in the study area. Groundwater in the study area seems to be highly polluted with nitrate.63% samples of the study area exceeded the maximum permissible limit of nitrate concentration set by WHO. Only 37% samples of the study area are suitable for drinking. Nitrate causes problems as a contaminant in drinking waters taken primarily from aquifers. In dealing with the nitrate problem, the treatment processes, such as ion exchange, reverse osmosis, biological denitrification and chemical reduction are useful. The non-treatment processes attempt to bring the nitrate concentration down to a safer level, through blending with cleaner waters. Prevention, such as reduced dependence on nitrogen-rich fertilizers, use dyes in textile industry can also lower the influx of nitrates to a large extent. Moreover, it is also important to educate the local population about keeping their surroundings clean, alternate use of the animal waste (as fuel) and to follow hygienic sanitation practices. Periodical monitoring of nitrate in drinking water is suggested.

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