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NITRATE AND FLUORIDE CONTENT IN GROUND WATER IN THE BATTICALOA DISTRICT

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Abstract

A preliminary investigation was done to determine the nitrate and the fluoride content in ground water in the Batticaloa district. Thirty-three wells have been selected from eight Divisional Secretary (DS) areas in this district and sixty-six samples were collected. Nitrate and fluoride content in these samples were analysed using nitrate and fluoride ion selective electrodes respectively.
The lowest nitrate content was observed at Thambalawatta as 1.49 mg/dm^3 *and highest nitrate content was observed at Mandur as* 96.60 mg/dm^3. *This analysis showed that 85% of these wells contain nitrate concentrations considered to be safe by WHO standard (<* 45 mg/dm^3*) and 15% of the wells had nitrate content of greater than* 45 mg/dm^3. *Therefore appropriate technologies for agriculture, sewage disposal and construction of soakage pits should be innovated to reduce the nitrate pollution. The study also revealed that the well water at Vantharumoolai contained the minimum amount of fluoride (*0.029 mg/dm^3*) meanwhile the well water at Aiyithiyamalai contained the maximum amount of fluoride (*0.685 mg/dm^3*). Only 18% of wells contain fluoride concentrations considered to be safe by WHO (*$0.5 - 1.5$ mg/dm^3*). Therefore some preventive measures such as fluoridation of ground water are necessary to protect the ground water quality.*

keywords: :Dental caries, Fertilizer, Fluoride, Nitrate, Sewage

1 Introduction

Concern has been expressed recently about the increasing levels of nitrate ion in drinking water, particularly in well water in rural locations. The main source of the nitrate ion is leacheate from agricultural lands. Initially, oxidized animal waste and

unabsorbed ammonium nitrate and other nitrogen fertilizers were thought to be the main sources. It now appears that intensive cultivation of land, even without the application of fertilizer or manure, facilitate the oxidation of reduced nitrogen to nitrate in decomposed organic matter in the soil by providing aeration and moisture[1]. Water containing more than 45 mg/dm^3 of nitrate ion is regarded unsafe for infants. Above this level in water, nitrate causes serious health hazard. Most commonly it could affect infants and children. Apparently, a microorganism in the gastro intestinal tract can convert nitrate into nitrite, which under the biological conditions oxidizes the ferrous in hemoglobin to ferric producing methemoglobin. Methemoglobin cannot transport oxygen in the blood and the resulting deficiency produces the characteristic bluish skin colour and give rise to methemoglobinamia (blue babies). Excess of nitrate could also affect the older children and adults[1].

Fluorine is considered as an essential element though health problems may arise from either a deficiency or an excess of fluoride. There is a wide spread interest in determining fluoride content in natural water particularly in ground water. Much of fluoride entering the human body is obtained from water. Human teeth are composed of calcium hydroxy apatite $Ca_5(PO_4)_3OH$. The fluoride ion is readily taken up by calcium hydroxy apatite and displaces some hydroxide ions. Fluoride ions enhance the precipitation of calcium phosphate and so may accelerate reminaralization. The formation of dental caries is initiated by the formation of plaque on the teeth surface. Acids produced by bacteria dissolve the enamel and is often not affected until substantial damage is caused to the subsurface regions. It is thought that fluoride ion can facilitate the formation of apatite at this stage, before the other surface is affected. Therefore fluoride is also used to stabilize the enamel mineral against decay. It is done either by the use of fluoride in toothpaste or by fluoridation of the drinking water[2].

The aims of this investigation are, to determine the distribution of nitrate and fluoride in ground water in the Batticaloa District and to discuss the impact of these ions on human health.

2 MATERIALS AND METHODS

The standard nitrate solutions of 1,2,4,8,10,20,40,80 and 100 mg/dm^3 were prepared using $NaNO_3$(AR). Denver, AP 25 ion selective/pH/coductivity meter was used to determine the nitrate content. From the above standards solutions 50.0 cm^3 aliquots were taken into a beaker and 5.0 cm^3 potassium dihydrogen orthophosphate buffer solution was added to each of the standard solutions and mixed well. The meter was calibrated using the above solutions. The sample of 50.0 cm^3 was transferred into a 100 ml volumetric flask and 5.0 cm^3 buffer solution was added. Direct readings were taken from the meter by putting the nitrate ion selective electrode into the prepared samples[3].

Total ionic strength adjustment buffering solution was obtained commercially and 0.1, 0.5, 1.0, 5.0, 10.0, 20.0. 40.0, 50.0 mg/cm^3 standard fluoride solutions were prepared using NaF(AR). Denver, AP 25 ion selective/pH/coductivity meter was used to determine the fluoride content and the meter was calibrated using the above standards. The sample of 50.0 cm^3 was transferred into a 100 ml volumetric flask and diluted to the mark with the buffering solution. Direct readings were taken from the meter by dipping the fluoride ion selective electrode into the prepared samples[4]. Table 1 shows the description of the sample stations and its index.

Table 1: Description of the sampling stations

Sample Station No.	Divisional Secretary division	Location
1	Koralai Pattu North	Valaichchenai
2		Kumburumoolai
3		Kiran
4		Santively
5	Eravur Pattu	Sittandy
6		Vantharumoolai
7		Eravur
8		Thannamunai
9	Manmunai Pattu North	Kallady
10		Urany
11		Puliyantivu
12		Mamangam
13	Manmunai Pattu and Kattankudy	Kirankulam
14		Puthukudiyiruppu
15		Araipattai
16		Kattankudy
17	Manmunai Pattu South and Eruvil Pattu	Krukkalmadam
18		Kaluthavalai
19		Paddiruppu
20		Kallar
21		Thuraineelavanai
22	Manmunai Pattu West	Kannankudah
23		Aiyithiyamalai
24		Vavanativu
25		Illupadichchenai
26	Manmunai Pattu South-West	Ambilanthurai
27		Kadukamunai
28		Paddipalai
29		Kokadichcholai
30	Porativu Pattu	Mandur
31		Vellavely
32		Thambalawatta
33		Palamunai

3 RESULTS AND DISCUSSION

Figure 1 shows that the nitrate content ranged from 1.49 mg/dm^3 to 96.60 mg/dm^3. Table 2 illustrates that 85% of the wells had water with nitrate content of less than 45 mg/dm^3, which is WHO recommended level of nitrate in drinking water meanwhile the rest of the wells contained higher nitrate concentrations. The mean nitrate levels of all the three different categories of waters in the Batticaloa District were considerably higher than the nitrate concentration of the domestic wells in Jaffna (4.52 mg/dm^3) and lower than that of agro wells in Jaffna (134.68 mg/dm^3)[5].

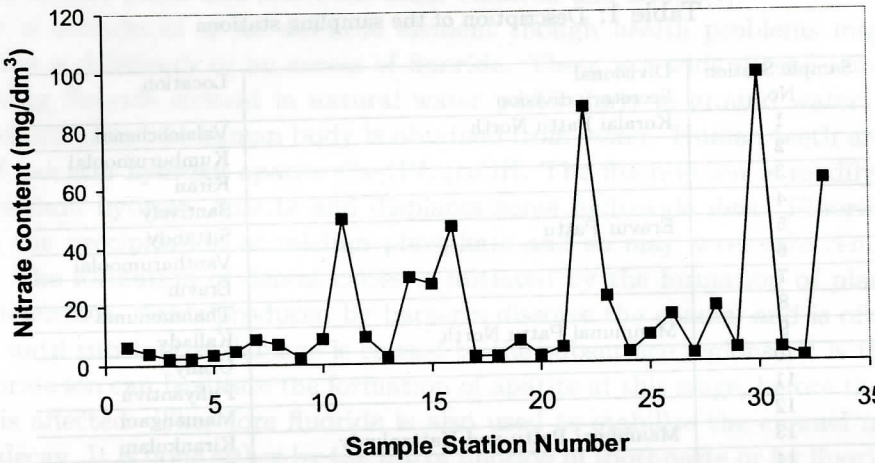

Figure 1: Nitrate content in ground water in the Batticaloa district

Table 2: Nitrate content in drinking water in the Batticaloa district. **SD**-Standard Deviation

Category of well water with respect to nitrate mg/dm^3	**No. of wells**	**Mean nitrate content** mg/dm^3	**SD**
Batticaloa < 25	26	6.30	5.37
25-45	2	28.35	1.34
45-100	5	61.45	22.52

In a study on distribution of nitrate in potable waters in Sri Lanka, high levels have been found in and around the cities indicating a possible relationship with the

population density and in a study on pollution of the coastal aquifers of Sri Lanka, the latrine soak ways have been suggested to be the most probable contributing factor for the elevated nitrate[6]. However, the nitrate levels were also considered to be due to leaching of nitrogenous fertilizers from paddy lands and intensively cultivated soils. The heavier application of nitrogenous fertilizers for agricultural practices coupled with the closed aquifer is probably the primary factor responsible for the very high concentrations of nitrate in the well water[7]. In addition, a clear relationship has been shown between the land use and ground water quality at the Kaluthawalai in the Batticaloa district[8].

In a study on ground water pollution in Batticaloa, higher nitrate contents($3.18 - 3.46\ mg/dm^3$) were observed in the wells which were very close to the cemetery and it has been suggested that this may be due to the leaching of nitrate from decomposed buried human dead bodies[8].

The water samples collected from Kannankudah ($87.40\ mg/l$), Mandur ($98.60\ mg/dm^3$) and Palamunai ($62.40\ mg/dm^3$) had higher nitrate content and this may be due to the intense agricultural activities. In certain parts such as Puliyantivu ($49.40\ mg/dm^3$), where there is no intensive cultivation, the nitrate level in well water approaches to greater than WHO recommended level. This is probably due to the inadequate sewage disposal facilities. Also in thickly populated area such as Kattankudy ($46.60\ mg/dm^3$) the wells are situated close to the soakage pits of the toilets and this may result in increased level of nitrate in well water.

Figure 2 shows the fluoride content ranged from 0.029 to $0.685\ mg/dm^3$. Table 3 shows that 82 % of the well had water with F^- content of less than $0.5\ mg/dm^3$, meanwhile the rest of the wells contained $0.5-1.5\ mg/dm^3$ F^- concentration, which is the WHO recommended level of fluoride in drinking water.

Table 3: Fluoride content in drinking water in the Batticaloa district.

Category of well water with respect to fluoride(mg/dm^3)	No of wells	Mean fluoride Concentration (mg/dm^3)	SD
Batticaloa < 0.5	27	0.172	0.125
0.5-1.5	6	0.571	0.062

The mean fluoride of two different categories of waters in the Batticaloa district is considerably greater than that of in Jaffna ($0.085\ mg/dm^3$)[9]. Fluoride in ground water at Manmunai Pattu west and Porativu Pattu Divisional Secretary divisions were greater than $0.5\ mg/dm^3$ and less than $1.5\ mg/dm^3$. Ground water in these areas promotes dental health resulting in healthy teeth and prevents tooth decay. This water is suitable for drinking as far as fluoride content is concerned. The other areas had fluoride content lesser than $0.5\ mg/dm^3$. Since fluoride enters the body

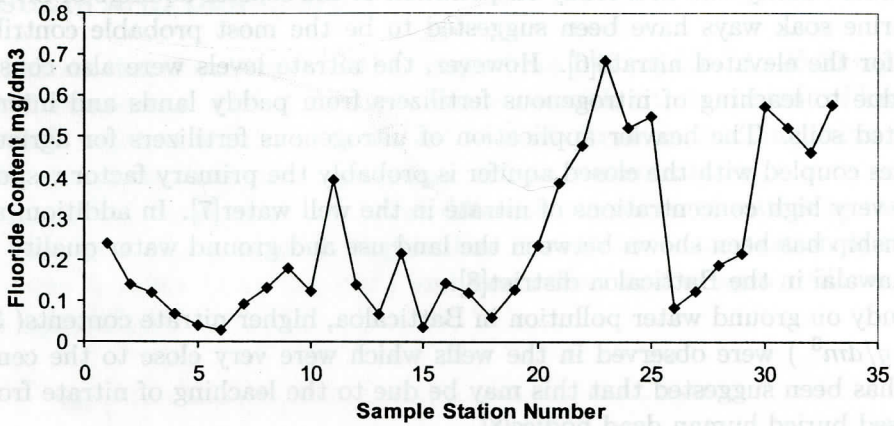

Figure 2: Fluoride content in ground water in the Batticaloa district

mainly from the drinking water supplies, people in these areas may have the risk of dental caries.

4 Conclusions

The build up of nitrate content in ground water in rural area in the district where agricultural activities are high can be controlled by adopting appropriate agricultural practices such as use of slow release fertilizers, incorporation of green manure and by educating the farmers on fertilizer uses and impact of agricultural practices on ground water. In urban areas where population is high, for example in Kattankudy area, nitrate content in ground water can be controlled by adopting appropriate technology for sewage disposal and construction of soakage pits.

Because nitrate removal from well water is very expensive, it is better to prevent ground water from the nitrate contamination by awareness programmes through the media and school education.

The presence of less fluoride in their water supply is not known to the vast majority of the people in the Batticaloa district who are almost totally ignorant of the dangers of deficiency of fluoride in their drinking water.

While the use of fluoridated toothpaste is used extensively in Sri Lanka as a preventive measure against dental caries, most of the people in the rural area do not use fluoridated toothpaste. Therefore the awareness of the dental caries problem should be enhanced in the Batticalao district through the media and school education.

The results also reveal that there is no risk of fluorosis in this district and there is no necessity to fluoridation or defluoridation or to market fluoridated toothpaste in Manmunai pattu west and Porativu pattu divisional secretary divisions. However further investigation should be carried out to correlate the relationship between dental caries and the fluoride in ground water in this district.

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