DETERMINATION OF NITRATE ANION IN WASTE WATER FROM NINE SELECTED AREAS OF COASTAL GUYANA VIA A SPECTROPHOTOMETRIC METHOD

R. C. Jagessar [1,*] & L. Sooknundun[2]

[1]Senior Lecturer, Department of Chemistry, University of Guyana.
[2]Final Year student, 2009-2010, University of Guyana, Turkeyen Campus, P.O. Box, 10-1110, Georgetown, Guyana

ABSTRACT

Globally, the presence of nitrate anions in water beyond the threshold limit can be deleterious to both flora and fauna life. Guyana's waste and domestic water needs monitoring to assess the concentration of toxic anions and cations. High levels of nitrate anion beyond the threshold limit can induce the "blue baby" syndrome amongst other effects. This paper focuses on the determination of nitrate anion concentration from nine selected areas of coastal Guyana using an Ultra Violet Spectrophotometric method. These areas monitored were No. 58 Livehood Village, Rose Hall Town, Skeldon GUYSUCO Estate, Good Hope, Ogle, Stabroek, Parika, Supenaam, Spring Garden. The results showed that the concentrations of nitrates were not as high and are below the internationally accepted threshold values. The average concentration being 0.03mg/L, 0.06mg/L and 0.20 mg/L, 1.77 mg/L, 2.363 mg/L, 0.333mg/L, 0.17 mg/L, 0.19 mg/L, 0.18mg/L NO_3^- for the above several areas respectively. The results were accepted at the 95% confidence leve using statistical analysis. The US public Health Service designated safe limit for nitrate in water as 45mg/L.. The applicable range of concentrations using the above method is 0.1-2 mg/L NO_3^-. A maximum level of 45 mg/L is established as worldwide guidance for nitrate concentration in water. In Europe, the maximum permitted levels of nitrate in potable water is 50.0 mg/L, while in the US-EPA has established a guideline for the maximum level of nitrate-nitrogen of 10 mg/L. It can safely be informed that the nine selected areas choosen are not polluted with anions. In an effort to improve water quality, the Government of Guyana has embarked on the construction of sand filtration and water treatment plants along the inhabited coastland of Guyana.

Keywords: *Nitrate, threshold limit, flora and fauna, Spectrophotometric method, effluent, 95% confidence level*.

1. INTRODUCTION

This paper investigates the nitrate ion concentration in waste water from a total of nine selected locations in the county of Berbice, Demerara and Essequibo: *No. 58 Livehood Village, Rose Hall Town, Skeldon GUYSUCO Estate, (Berbice) Good Hope, Ogle, Stabroek, (Demerara) Parika, Supenaam, Spring Garden (Essequibo)* via an Ultraviolet Spectrophotometric method, Eaton et. al [1]. The latter is applicable to the analysis of drinking water, surface waters, domestic and industrial waters, Eaton et.al [2] and Booth et.al [3]. The method can be modified to compensate for turbidity, colour, salinity and dissolved organic compounds in the sample.

Waste water is one that has been used for washing, flushing, or that which is released from manufacturing processes, Eaton et. al [1] and Eaton et. al [2]. In Guyana, groundwater provides 90 percent of the potable water supply and is extracted mainly from the coastal artisan basin' Jagdeo et. al [5]. However, potable water can be contaminated. The most common examples of resource contamination in Guyana are those arising from water pollution: Elemental such as mercury, anions: cyanide, phosphates, nitrates, chlorides and cation in calcium and other wastes from mining etc.. However, their level of concentration needs to be determined. Others include untreated human and animal wastes in water supplies and wastes from many industries in water tables, Williams et. al [4] and Jagdeo et. al [5].

Providing sufficient quantities of high quality water to satisfy our domestic, industrial and Agricultural needs is an on going global problem. Increasing population size, climate change and pollution will only exacerbate the situation. There is no physical shortage of water on the planet earth. It covers 70% of the globe. However, 97% of the world water is saline and is thus non-drinkable. 2% is locked in glaciers and polar ice caps. This leaves 1% to meet humanity needs' Elliot et. al [6].

Some anions are toxic at certain concentrations because of their mobility in living systems and abilities to cross cell membranes. Toxic anions are poisonous and can cause harm or even death via malfunctioning of the organs such as the kidney etc. They usually enter the body via drinking waters, food, fruits and vegetables, fish and other foods in

general that may have been exposed to such waters. Thus, the levels of concentration of anions must be controlled in our water bodies.

Nitrates (NO_3^-) are salts of nitric acid and are triangular in shape, Figure 1.0. Major contributors of nitrate are chemical fertilizers from cultivated land and drainage, from livestock feedlots, as well as domestic waste and some industrial waters in the course of leakage. Unpolluted natural waters contain only miniature amounts of nitrate. In surface water, nitrate is a nutrient which is taken up by plants and assimilated into nucleic acid.

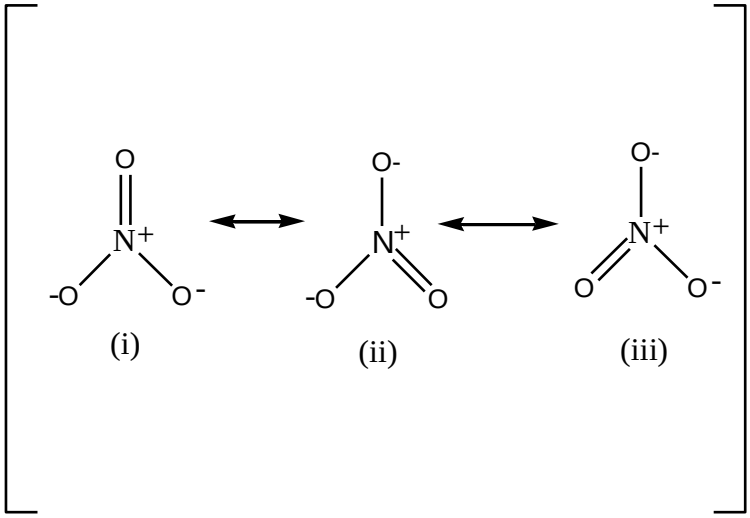

Figure. 1.0, Resonance in Nitrate ion

Nitrate anion has both beneficial and harmful uses. On the positive side, Nitrates (NO_3^-) are essential plant nutrients that are important ultimately for protein synthesis. They are responsible for the growth of plants and also nitrogen fixation. Nitrates are found in nature since they are the end product of the aerobic decomposition of organic nitrogenous matter as well as the decomposition of organic micro-organisms.

Nitrogen, an element of nitrate is part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. It is also a component of chlorophyll, the green pigment of the plants that is responsible for photosynthesis. Nitrogen also helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.

On a negative note**,** high concentrations of nitrate in drinking water can cause blood disorder in babies less than six months of age. In infants intestine, bacteria, notable *Escherichia Coil*, reduce the nitrate ions (NO_3^-) to nitrite ions (NO_2^-). The nitrite ions are absorbed into the bloodstream where they oxidized iron (ii) Fe^{2+} in the hemoglobin to iron (iii) Fe^{3+}. The presence of hemoglobin containing oxidized ion which is known as Met-hemoglobin reduce the oxygen carrying capacity of the blood. More Babies are more vulnerable to high nitrate levels than adults because their stomachs are less acidic. This allows the *E. coil* to colonize higher up the digestive tract and convert the nitrate ions to nitrite prior to absorption. The use of unsterilized feeding bottles can increase the rick of met-hemoglobin formation. The danger lies in the ability of the bacteria present in the feeding bottle to convert the nitrate in the water to nitrite. A concentration of met-hemoglobin in the blood above 25% cause the skin and lips of the infected infant to take on a bluish hue, the 'Blue Baby Syndrome' or Met-hemoglobinaemia. If untreated, the condition can be fatal. Boiling water contaminated with nitrate increases the nitrate concentration and the potential risk.

The excess of nitrates are largely due to the presence of animal manure in the water bodies. This manure is concentrated with ammonia which is not only highly toxic to fish, but can also be converted to dangerous nitrates. Nitrate-nitrogen also comes from the atmosphere and more specifically from snow, fog, or through the decay of material in soil and sediments. Added to their effects to humans they promote the growth of plants and algae in our water bodies thus increasing their populations. With the increase growth in these plants and algae in the soil and water, there is a competition for oxygen in the water body leading to tremendous deaths of these organisms which eventually results in a build up in decaying matter which may even lead to the filling up of ponds and lakes, thus destroying or creating an imbalance in the entire ecosystem, if not dealt with in time. This process is specifically being referred to as **Eutrophication**, the process of enriching water or algal blooms. Eutrophication is also a cause of the loss of diversity in the sea floor community (including seaweeds, sea grasses, and corals), and amongst planktonic organisms. Since planktonic algae are the basis of marine, their absence will affect the ecological food

chain and food webs tremendously. The excess of nitrates contributed to the high levels of Eutrophication in most of our drains and trenches in the capital city (Georgetown) in Guyana, other towns and villages in Guyana. Sources of nitrate contamination include fertilizers, animal wastes, septic tanks, municipal sewage treatment systems, and decaying plant debris.

The determination of nitrate (NO_3^-) is a difficult task because of the relatively complex procedures involved, the high probability that interfering constituents will be present and the limited concentration ranges of the various techniques. An Ultra Violet technique that measures the absorbance of Nitrates at 220 nm is suitable for screening uncontaminated water (low in organic matter).This method is applicable to the analysis of drinking, surface and saline waters.

2. EQUIPMENT/MATERIALS

UV Spectrophotometer**,** Hot plate**,** Volumetric pipettes: 2,5 and 10 mL**,** Calibrated pipette**,** Fume hood**,** Analytical balance**,** Volumetric flask: 50-,100-,500-,1000 mL**,** Weighing boat**,** Funnel.

3. PROCUREMENT OF WATER SAMPLES

(a) Procurement of Water samples.

Water samples were collected in plastic bottles from the various sites. However, before the actual visit to the sites, plastic bottles were first cleaned. They were washed thoroughly with detergent, rinsed with HCl, followed with distilled water for a prolonged period. These bottles when dried was secured with lids being treated in the same way. They were labelled and wrapped in black plastic bags to prevent the access of light to the samples. Samples were taken by holding the bottle near its base in the hand and plunging it, neck downward, below the surface. The bottle was turned until the neck points are slightly upward and mouth is directed toward the current. When sampling from a boat, samples was obtained from the upstream side of the boat. When it was not possible to collect samples from these situations in this way, a weight was attached to the base of the bottle which was lowered into the water. In all cases, care was taken to avoid contact with bank or stream bed to prevent water fouling. Sampling bottles were kept closed until it was filled and much caution was taken not to contaminate the inner surfaces of stoppers, caps and necks of bottles. Containers were filled without rinsing while the stopper or cap was immediately replaced, ensuring to secure the hood around the neck. Samples were collected in plastic bottles and stored at 4^0C for a maximum holding time of 48 hours. The minimum quantity required is 100 ml.

Samples were then taken for analysis where they were acidified using 1N hydrochloric acid in order to prevent interference from hydroxide or carbonate concentrations up to 1000mg $CaCO_3$/L. They were then analysed immediately for nitrates, using a Spectrophotometric method, Eaton et. al [1], Eaton et. al [2] and Booth et. al [3].

Table 1.0: Sample locations for water samples collected from nine different locations

Key	Location
1a	No. 58 Village
1b	Rose Hall Town
1c	Skeldon GUYSUCO Estate
2a	Good Hope
2b	Ogle
2c	Stabroek
3a	Parika
3b	Supenaam
3c	Spring Garden

KEY:

1a……..No. 58 Village
1b……..Rose Hall Town
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3c…….. Spring Garden

Reagents: Phenoldisulphonic acid**,** Ammonium hydroxide, NH_4OH

4. THE PREPARATION OF REAGENTS

(a) Water: .

Laboratory grade distilled water was used for all activity. This was obtained by distilling water from a still of all-borosilicate glass, fused quartz, tin, or titanium. Distillation from an acid solution was introduced to remove ammonia. CO_2 was removed by boiling the water for 15 minutes and cooling rapidly to room temperature, while atmospheric CO_2 was excluded by using a tube containing soda lime or a commercially available CO_2 removing agent. Since boiling the water may add other impurities by leaching impurities from the container, fresh filters regularly replaced old ones. Cartridges and resins initially can release impurities as well. Pretreatment on reagent water was carried out where water contains significant concentrations of calcium, magnesium, and bicarbonate ions. When required, demineralization via reverse osmosis or ion exchange was also introduced.

(b) Nitrate standard (Potassium nitrate); 10ppm [made up from 1000ppm stock solution].

5.0g of potassium nitrate (KNO_3) was dried at 103-105^{0}C for 1 hr and stored in a desiccator until it was cool. 3.6107g of potassium nitrate (KNO_3) was weighed and washed over into a 500ml flask with distilled water (1000ppm standard). It was closed, shaken vigorously and then labelled; 50mL was pipette into a 500mL volumetric flask. The sample was then diluted to 500mL with distilled water (100ppm stock standard.) and again it was closed, shaken vigorously and labeled. 10mL was then pipette from the 100ppm stock solution into 100mL volumetric flask and it was made up to mark (10 ppm standard). It was closed, shaken vigorously and then labeled.

(c) Sample preparation:

5ml of distilled water was pipette in to 150ml beaker (blank). 5ml of sample was then added to 150 ml beaker (sample volume), and placed on a hotplate and taken just to dryness. 2ml of phenoldisulphonic acid was added and the sides were washed down lightly, warmed on hotplate, removed and allowed to cool. 10ml of concentrated ammonium hydroxide was then added carefully in fume hood. It must be noted that **reaction was violent!** Adding the hydroxide directly to the sample was avoided since the reaction is violent. Samples were prepared in triplicates and was brought to room temperature.

It was added carefully to a 50ml volumetric flask, washed cleaned and made up to mark with distilled water. The concentration (absorbance) was measured with the UV spec at 410 nm. The same procedure was followed for standards, Absorbance readings were recorded. **The following are the quantities of standards that were placed in a beaker:** 1 ml of 10ppm was pipette into 150 ml beaker = 10 ppm, 2 ml of 10 ppm was pipette into a 150ml beaker = 20 ppm, 3 ml of10 ppm was pipette into 150 ml beaker = 30 ppm. A standard graph was then prepared and this is shown in Figure. 2.0.

(d) Preparation of Phenol (1, 3) - Disulphonic acid

Phenoldisulphonic acid was prepared by dissolving 25g of phenol in 150ml of conc. H_2SO_4. 35ml of fuming H_2SO_4 (30% SO_3) was added and the solution was heated at 100^{o}C for 2 hours on water bath.

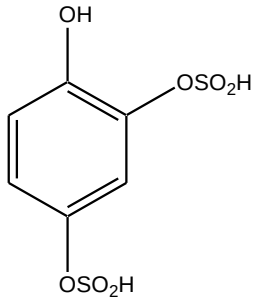


Figure. 2.0. Phenolsulphonic acid

5. CONTROLS/REFERENCES

Nitrates reference solutions were prepared.

6. RESULTS

The average (of replicates/triplicates) was expressed along with the standard deviation.

Table 1.0: **The following table shows the concentration and absorbance of the nitrate standards.**

Total Nitrate				
Concentration, mg/L	**Absorbance**			**Average**
10	0.117	0.119	0.056	0.097
20	0.206	0.143	0.205	0.206
30	0.300	0.250	0.363	0.304

According to the absorbance taken for the different concentrations of standards, is found to be proportional to concentration. Thus as concentration is increased absorbance also increased linearly, Figure 2.0. Thus this standard graph can also be used to estimate the nitrate concentration of samples at any given absorbance.

Figure 2.0, Graph 1.0: The following graph is a plot of the average absorbance of the standard against its concentration at 10, 20 and 30 mg/L nitrate.

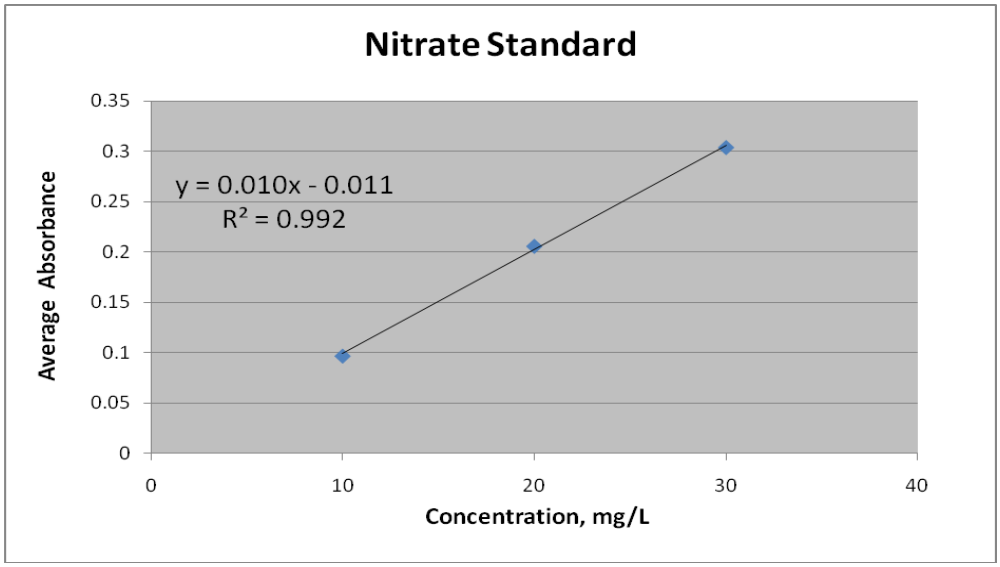


Table 2.0. The following table shows the absorbance of the blank which was used to calculate the corrected absorbance in the three counties.

Number	**County**	***Absorbance(Number) (nm)***	***Average absorbance***
1	Berbice	**0.054, 0.054, 0.054**	**0.054**
2	Demerara	**0.025, 0.060, 0.030**	**0.038**
3	Essequibo	**0.052, 0.051, 0.062**	**0.055**

NB: 5.00ml of distilled water was used as the blank.

7. CALCULATIONS

Calculations are in accordance with literature, Eaton et. al [1], Eaton et.al [2] and Booth et.al [3]

Nitrate ion concentration (Nitrate, mg/L) is calculated using (Corrected Absorbance x 4.43) / sample volume (mL) ---------- (1)

Where the value 4.43 is a constant.

The values obtained when the formula was used to calculate the nitrate concentration was

tabulated and the results shown as follows: Because of the numerous number of samples more than one blank were used. Distilled water was used as a blank.

Corrected or True Absorbance:

Total absorbance of the sample (TA) - Absorbance of the blank (AB) - - - - - - - - (2)

Table 3.0: **The table below shows the absorbance, corrected absorbance and the volume of sample use in order to calculate the nitrate concentration.**

No.	Corrected Absorbance	Absorbance	Volume(ml)
		BLANK	**0.054**
1a	0.042	0.096	5.00
	0.028	0.082	5.00
	0.032	0.086	5.00
1b	0.074	0.128	5.00
	0.075	0.129	5.00
	0.069	0.123	5.00
1c	0.119	0.173	2.50
	0.111	0.165	2.50
	0.113	0.167	2.50
		BLANK	**0.038**
2a	-0.002	0.036	0.040
	0.016	0.054	0.040
	-0.005	0.033	0.040
2b	0.016	0.054	0.040
	0.018	0.056	0.040
	0.030	0.068	0.040
2c	0.002	0.040	0.040
	0.004	0.042	0.040
	-0.005	0.033	0.040
		BLANK	**0.055**
3a	0.236	0.291	5.00
	0.200	0.255	5.00
	0.133	0.188	5.00
3b	0.268	0.323	5.00
	0.171	0.226	5.00
	0.210	0.265	5.00
3c	0.171	0.226	5.00
	0.180	0.235	5.00
	0.253	0.308	5.00

8. STATISTICAL ANALYSES

Statistical data were analysed in accordance with literature [12,13].

Standard Deviation

Standard deviation, S. The standard deviation was calculated using the formula below [12,13]:

$$S = \sqrt{\frac{\sum_{i=1}^{i=N} (x - \bar{x})^2}{N - 1}} \qquad (3)$$

X_i = individual values (calculated concentration at the specified corrected absorbance)

$\bar{X}$ = average concentration

N is the number of entries
The Standard deviation measures how closely the data are clustered about the mean. The smaller the Standard deviation, the more closely the data are clustered about the mean.

Variance : This is the square of the standard deviations. It is represented as σ^2 ------ (4)
Calculation of confidence limit or confidence interval.
The confidence limit at the 95% level was calculated using the formula [12, 13]:

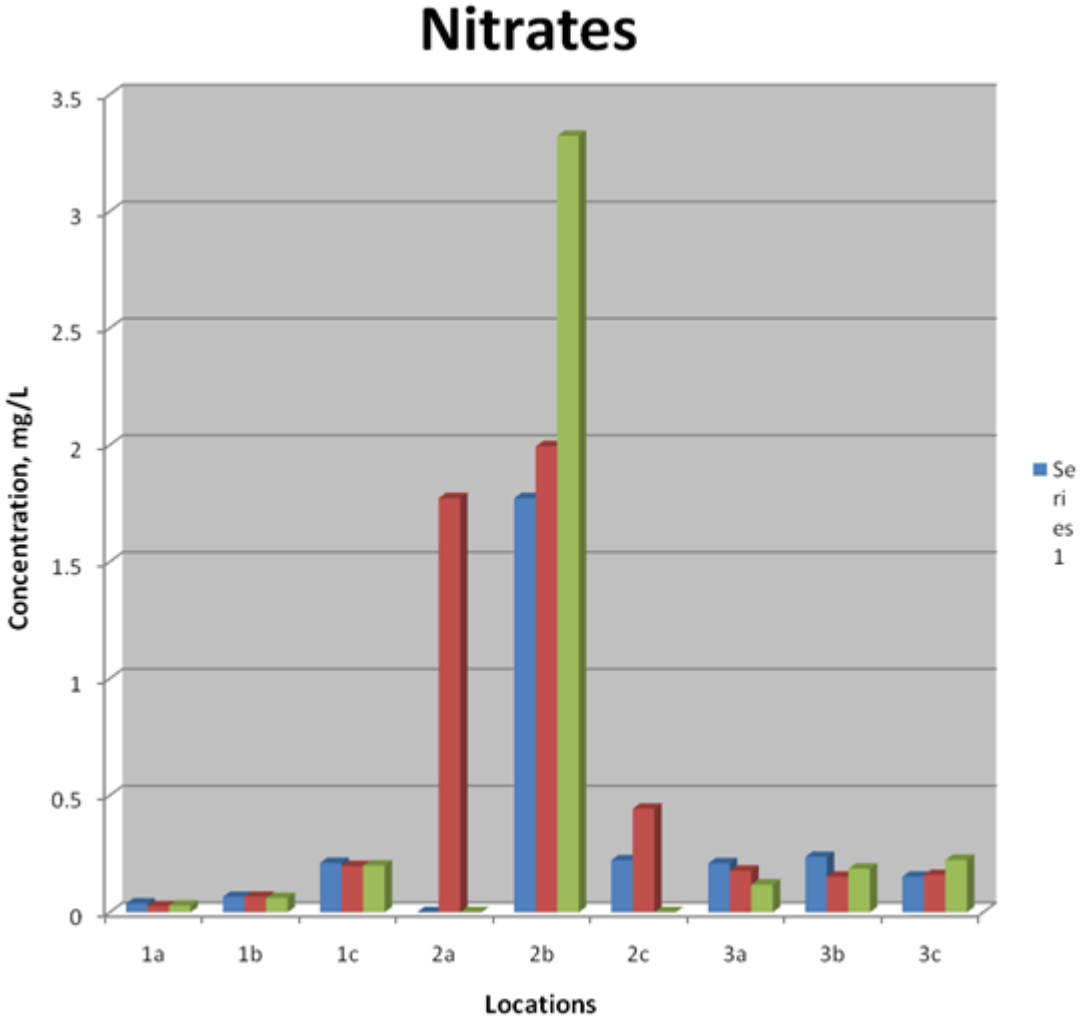
$$CL(\mu) = \overline{X} + \frac{zs}{\sqrt{N}} \qquad (5)$$

Where $\overline{X}$, is the mean, z is a statistical factor related to the probability limit required at the 95% level and is 1.96, s is the standard deviation and N is the number of entries.
The confidence interval indicates that the true mean, μ is likely to lie within a certain distance from the measured mean x.
Using the formulae for the Concentration, Standard Deviation, Variance and Confidence Interval, values were calculated and are presented in Table 4.0.

Table 4.0: The Table below shows the results obtained for the analysis of nitrates, where the concentration of nitrates was determined using the same formula above.

No.	Calculated (mg/L) Concentration	Average	Standard Deviation	Variants	Confidence at 95% Level
1a	0.037				
	0.025	0.030	0.00624	3.89×10^{-5}	0.030±0.0155
	0.028				
1b	0.066				
	0.066	0.064	0.00292	8.53×10^{-6}	0.064±0.0072
	0.061				
1c	0.211				
	0.197	0.203	0.00738	5.45×10^{-5}	0.203±0.0183
	0.200				
2a	-0.222 (nd)				
	1.772	1.772	0.00000	0.0000	1.772±0.0000
	-0.554 (nd)				
2b	1.772				
	1.994	2.363	0.83876	0.7035	2.363±2.0823
	3.323				
2c	0.222				
	0.443	0.333	0.15627	0.0244	0.333±0.4751
	-0.554 (nd)				
3a	0.209				
	0.177	0.168	0.04616	0.0021	0.168±0.1146
	0.118				
3b	0.237				
	0.152	0.192	0.04278	0.0018	0.192±0.1062
	0.186				
3c	0.152				
	0.159				
	0.224	0.178	0.03971	0.0016	0.178±2.5812

1 Figure, 3.0, Graph 2. The graph below shows the results obtained for the analysis of Nitrate at the three cothree counties of Guyana: Berbice, Demerara and Essequibo.



KEY TO GRAPH:

1a……..No. 58 Village
1b……..Rose Hall Town
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9. DISCUSSION

Due to increase Agricultural activities and industrailisation in Guyana, it is necessary that it's water be monitored for toxic anions and cations. Also, it has been found recently that high level of nitrate polluted Gaza wells of Palestinian water, Elliot [6]. This paper indicates the determination of nitrate anion concentration of waste water from nine selected areas of Coastal Guyana via an Ultra Violet Spectroscopy method: Areas monitored were *No. 58 Livelihood Village, Rose Hall Town, Skeldon GUYSUCO Estate, Good Hope, Ogle, Stabroek, Parika, Supenaam, Spring Garden.* The applicable (permissible range) for the detection of nitrate ion concentrations using the above Spectrophotometric method is 0.1-2 mg/L NO_3^{-} A maximum level of 45 mg/L in water is established internationally. In Europe, the maximum permitted levels of nitrate in potable water is 50.0 mg/L, while in the US-

EPA (Environmental Protection Agency) has established a guideline for the maximum level of nitrate-nitrogen of 10 mg/L. Nitrate forms a component of total dissolved solids, they are widely used as an indicator of water quality. However, there are deviation from this value in many places on the planet. For example, Internationally, the Helmholtz centre for environmental research in Germany have shown that Gazan (Gaza strip) groundwater from over 165 wells over a period of six years contains level of nitrates (NO_3^-) ions up to eight times higher than the World Health Organisation (WHO) safe standard. The high level of nitrates could be poisoning many newborn babies. The high level of nitrates originate mainly from run off from manure (either human or animal) used as fertilizer which is accentuated by the soil's high permeability, Peplow et. al [7]. It has been suggested that a 50% incidence rate of methaemoglobinaemia has been found. This disease lowers the amount of oxygen the blood can carry and sometimes lead to death

Nitrate in the water originates from contaminats in septic, livestock manure piles, or fertilizers. Large amounts of nitrate will cause Eutrophication, which means an excess of nutrients resulting in oxygen deprivation and fish deaths. In freshwater or estuarine systems close to land, nitrate can reach high levels that can potentially cause the death of fish. While nitrate is much less toxic than ammonia or nitrite levels over 30 ppm of nitrate can inhibit growth, impair the immune system and cause stress in some aquatic species.

The primary source of excess nitrate concentrations in aquatic systems is surface runoff from agricultural or landscaped areas that have received excess nitrate fertilizer. These levels of nitrate can also lead to algae blooms, and when nutrients become limiting such as Potassium, Phosphate or nitrate, then Eutrophication can occur. Eutrophication can lead to water anoxia and dead zones, favouring some groups of organisms over others.

For comparative purposes, nitrate standards at cocncentration of 10 ppm, 20 ppm and 30 ppm were prepared and the absorbance at these concentration was taken. Experiment was done in triplicates. A plot of average absorbance versus cocnecntration, mg/L is shown in Figure 2.0. Accordingly, the absorbance taken for the different concentrations of standards, is found to be proportional to concentration. Thus as concentration is increased, absorbance also increased linearly, Figure 2.0. Thus this standard graph can also be used to estimate the nitrate concentration of samples at any given absorbance. The NO_3^- calibration curve follows Beer's law up to 11 mg N/L.

In terms of sampling, water samples were collected from the nine selected areas during the non rainfall period so as to eliminate contamination resulting from rainfall run off. The results are shown in Table 3.0 and 4.0 and Graph 2.0, which is a plot of concentration of nitrate in mg/L versus locations indicate that the lowest concentration of nitrate was found in the county of Berbice, whereas the highest in Demerara. Nitrate ion concentration per county decrease according to the trend: Demerara > Essequibo > Berbice.. Considering the county of Berbice, values of 0.030mg/L, 0.064mg/L and 0.20 mg/L were obtained for Number 58 Livelihood Village, Rose Hall Town and Skeldon Sugar Estate respectively. The highest concentration at Skeldon GUYSUCO (Guyana Sugar Corporation) waste water is due to the use of nitrate fertilizers used by sugar cane farmers for the cultivation of Sugar cane and the permeability of the soil. Interestingly, the lowest concentration was obtained for Number 58 Livelihood Village, a village where predominatly cash crop cultivation is done but which has seen a decline in the past decade due to migration of residents overseas. This low value may be ascribed to the increased rate of evaporation and transpiration that caused the plants to use up the nitrates almost as immediately as they become available. This also contributed to the soil being very dry, hence there was little downward movement of water in the soil, and thus less nitrates were being leached through the soil to the nearby water system where the samples were collected. Also, it may result from the low permeability of the soil. It is anticipated that if samples were to be taken in the rainy season, a larger concentration of nitrates would be found in the nearby water ways.

The highest concentration of nitrate was found in the county of Demerara. These been 1.772mg/L, 2.363 mg/L and 0.33 mg/L for Good Hope, Ogle and the Stabroek areas respectively. The Highest concentration at Ogle is also surprising considering that it's a residential area now but there is some form of crop cultivation done by residents there. The highest concentration of nitrate may be due to run off in trenches, canals from sugar cane lands from nearby Sugar cane estate from other regions. It may also due to nitrogen from industrialized waste from these sugar cane factories and also to the high permeability of the soil. The soil probably has a high nitrate content due to past agricultural activities but has now become residential. Nitrate is also a by-product of the septic tank systems. It is a naturally occurring chemical that results from the breakdown or decomposition of animal or human waste. Water quality is also be affected through ground water resources that have a high number of septic systems in a watershed. Septics leach down into ground water resources or aquifers and supply nearby bodies of water. The high level of nitrate at Ogle may also result from septic tanks leaching to the nearby water trench. The lowest concentration of nitrate at Stabroek is expected considering that it's the capital city of Georgetown and its non-agricultural.

The second highest concentration of nitrate was found in the county of Essequibo which is predominantly a farming county for cash crops and large scale rice production. Values of 0.168mg/L, 0.192mg/L and 0.178 mg/L were registered for Parika, Supernaam and Spring Garden.

The overall low concentration of nitrate in these nine areas from the three counties indicate that they are below the threshold limit of 45mg/L as established world wide. Thus, it can be concluded that these areas are not contaminated with nitrate. However, further testing of other water ways in Guyana needs to be done to safely conclude that Guyana water is free from nitrate pollution beyond the threshold limit. No cases of "Blue Baby" syndrome has been reported here in Guyana to the best of knowledge.

10. CONCLUSION

It can be concluded from the analysis of nitrate ion, the concentration was found to be 0.030mg/L, 0.064mg/L, 0.203mg/L, 1.772mg/L, 2.363mg/L, 0.333mg/L, 0.168mg/L, 0.192mg/L, 0.178mg/L at # 58. Livelihood Village, Rose Hall, Skeldon Guysuco Estate, Good Hope, Ogle, Stabroek, Parika, Supenaam and at Spring Garden respectively. These values are well below the Internationally accepted value of 45mg/L indicator for nitrate ion contamination and thus these water are not polluted with Nitrate beyond the threshold value. However, other water systems must be monitored in Guyana.

11. ACKNOWLEDGEMENTS

Gratitude is extended to the University of Guyana for the provision of chemicals. Analytical services were done at the Institute of Applied Sciences and Technology (IAST), Turkeyen. Special thanks to Lana Langevine of IAST.

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