JOURNAL OF SCIENCE, TECHNOLOGY AND EDUCATION (JSTE) VOL. 6. NO. 11

JSTE PUBLICATIONS, 2023 www.nsukjste.com/

ISSN: 2651-5539

AN ASSESSMENT OF THE LEVEL OF NITRATES IN DUG WATER SOURCES AND SELECTED FOODS IN JOS PLATEAU

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Citation: Dalaham, P. D. and Saliha M. (2023). An Assessment of the level of nitrates in dug water sources and selected foods in Jos Plateau. *Journal of Science, Technology, and Education (JSTE)*; www.nsukjste.com/ 6(11), 113-129.

Abstract

Nitrate levels in our water resources have increased in many areas of the world largely due to applications of inorganic fertilizer and animal manure in agricultural areas. The regulatory limit for nitrate in public drinking water supplies was set to protect against infant methemoglobinemia, but other health effects were not considered. Risk of specific cancers and birth defects may be increased when nitrate is ingested under conditions that increase formation of N-nitroso compounds. This study investigated the nitrate level in underground waters and some foods. The study revealed that dug wells seems to be the most prone to nitrate contamination and that wells with high nitrates were those located in close proximity to pit latrines and septic tanks. The nitrate values in wells water are affected by depth and distance from septic tanks and construction of the wells. It was also revealed that boreholes with high nitrate concentrations are those located in close proximity to the septic tanks. The nitrate values in water from boreholes also dependent on depth and construction of the boreholes and also upon their locations.it was revealed that the level of nitrate contamination in the samples both dug well and drilled boreholes are generally below the World Health Organization (WHO) specified unit of 45mg/I, with high nitrate concentrations in some foods with green beans having the highest concentration. The study concluded that the level of nitrate concentration in underground waters and foods are dependent on the physical and chemical characteristics of the leachates, types of soil, and fertilizers used and method of its fertilizer application, proximity to septic tanks, pit latrines, open drains and depth of the water supply. The study therefore recommended that there is an urgent need to introduce routine analysis of water sources to determine the level of Nitrates in our water system

Keywords: Nitrate, Dug water, Selected food, Compounds, Animal manure.

Introduction

Nitrates are the most stable of all nitrogen compounds, a basic nutrient for many photosynthetic autotrophs and inorganic compound that occurs under a variety of conditions in the environment both naturally and synthetically. Nitrate does not normally cause health problems unless it is reduced to nitrites. Nitrates are essential source of Nitrogen (N) for plants. When nitrogen fertilizers are used to enrich soils, nitrates may be carried by rain, irrigation and other surface waters through the soil into groundwater.

Nitrates are formed when microorganisms break down fertilizers, decaying plants, manures or other organic residues. Due to the alteration of nitrogen cycle dramatically over the last half-century, nitrate is steadily accumulating in our water sources. Naturally, nitrates in water result from the microbial degradation of organic nitrogenous materials such as protein to ammonium ions (NH_4^+) which are then biologically oxidized to nitrate in two-steps processes, namely, 'Nitrosomonas specie' for the oxidation of ammonium ion to nitrite and 'nitro-bacteria specie' completes the nitrification process by oxidizing nitrite to nitrate.

In most cases, higher level of occurrence is as a result of human activities. The major sources of nitrate in the environment are sewage, sullage and waste water from open drains, industrial effluents, garbage and waste from domestic animals. The underground water sources are susceptible to nitrate contamination caused by seepage from septic tanks, pit latrines, waste water from open drains and storm runoffs.

Generally, nitrates reach ground waters through two pathways, firstly, runoff especially from the refuse dumps, industrial wastes and agricultural areas. The nitrate load from these areas varies with the season and depends on some certain factors such as depth, distance, temperature, slope and amount of rainfall. The second pathway is infiltration. In agricultural areas and industrial waste dumps, nitrates infiltration into the soil especially during wet season. The important conditions that determine the eventual fate of nitrates are the soil condition, agricultural management and practice.

Presence of nitrates in vegetables and foods like lettuce, cereals, beets, spinach, carrots, green beans among others, at varying levels is dependent on the amount of fertilizer applied and on other growing conditions. According to World Health Organization (1998) nitrate exposures through intake of these foods are not thought to be harmful.

The threats from nitrates originating from water supplies and foods are increasingly felt in many parts of the world as they are known to cause methaemoglobinemia in infants. Methaemoglobinemia occurs when elevated levels of methamoglobin (exceeding about l0%) interfere with the oxygen carrying capacity of the blood. Infants are particularly susceptible to methaemoglobinemia for several reasons; including their lower levels of the enzyme 'cytochrome B_5 reductase' which converts methaemoglobin back to haemoglobin.

The ingestion of nitrates and nitrites could accelerate the conversion of Haemoglobin to its oxidized derivatives methaemoglobin and so induce cyanosis.

Methaemolobinemia is the most significant health problem associated with nitrate in drinking water. Blood contains an iron-based compound called haemoglobin, which carries oxygen. When nitrite is present, Haemoglobin can be converted to methaemoglobin, which cannot carry oxygen. In the blood of adults, enzymes continually convert methaemoglobin back to Haemoglobin and methaemoglobin levels normally do not exceed one percent.

New born infants have lower levels of these enzymes and their methaemoglobin level is usually 2-3 percent. At higher levels, symptoms of cyanosis usually appear. Babies with this condition have bluish mucous membranes and may also have digestive and respiratory problems. At methaemoglobin higher levels of 50-30 percent, brain damage or death can occur. However, greatest risk of nitrate poisoning (Methaemoglobinemia) occurs in infants fed with well water contaminated with nitrates (United State Environmental Protection Agency (USEPA, 2017). Moreover, home-prepared infant's foods from vegetables and grains (maize, millet, wheat) should be avoided until infants are three months or older. Breastfed infants are not at risk of nitrate poisoning from mothers who ingest water with high nitrate level, but pregnant mothers are at high risk of having babies with birth defects and also lower the amount of oxygen available to fetus. Symptoms are usually minimal until methemoglobin concentrations exceed 20% and manifests generally with few clinical signs other than cyanosis, which results to death.

Therefore, protection of drinking water supply from contamination with nitrate is important for health and to minimize potential liabilities. High levels of nitrates are associated with poorly constructed wells or improperly located wells. Locate new wells uphill and at least 100 feet away from feedlots, septic tanks, barnyards, properly seal or cap abandoned wells.

Nitrate values are commonly expressed as either nitrate (NO_3) or Nitrate-Nitrogen (NO_3N) with the maximum contaminant level (MCL) which is the highest level of NO_3 or NO_3N that is allowable in public drinking water supplies by the U.S Environmental Protection Agency (EPA) as 45mg/L for nitrate and 10mg/L for nitrate-nitrogen.

The Broad objective behind this study is to determine the Nitrate levels in both underground waters and foods. The study emphasizes on the need to introduce routine analysis of water and foods for nitrates in laboratories and also control measures aimed at arresting the nitrate levels in underground waters and foods in Jos South metropolis.

The study therefore reports on the concentration levels of nitrates in underground waters, and in foods such as carrot, green beans and garbage, variations of nitrate levels with dept of boreholes and proximity of water to assumed sources of nitrates

Statement of Problem

Since the mid-1920s, humans have doubled the natural rate at which nitrogen is deposited onto land through the production and application of nitrogen fertilizers (inorganic and manure), the combustion of fossil fuels, and replacement of natural vegetation with nitrogen-fixing crops such as soybeans (Davidson, David, Galloway, Haeuber, Harrison, Howarth, Jaynes, Lowrance & Nolan, 2012). The major anthropogenic source of nitrogen in the environment is nitrogen fertilizer, the application of which increased exponentially after the development of the Haber–Bosch process in the 1920s. Most synthetic fertilizer applications to agricultural land occurred after 1980 (Howarth, 2011). Since approximately half of all applied nitrogen drains from agricultural fields to contaminate surface and ground water, nitrate concentrations in our water resources have also increased (European Environment Agency, 2018).

The maximum contaminant level (MCL) for nitrate in public drinking water supplies in the United States (U.S.) is 10 mg/L as nitrate-nitrogen (NO_3-N). This concentration is approximately equivalent to the World Health Organization (WHO) guideline of 50 mg/L as NO_3 or 11.3 mg/L NO_3-N (multiply NO_3 mg/L by 0.2258). The MCL was set to protect against infant methemoglobinemia; however other health effects including cancer and adverse reproductive outcomes were not considered (USEPA, 2017). Through endogenous nitrozation, nitrate is a precursor in the formation of *N*-nitroso compounds (NOC); most NOC are carcinogens and teratogens. Thus, exposure to NOC formed after ingestion of nitrate from drinking water and dietary sources may result in cancer, birth defects, or other adverse health effects. Nitrate is found in many foods, with the highest levels occurring in some green leafy and root vegetables (International Agency for Research on Cancer, 20107& National Research Council, 1981). Average daily intakes from food are in the range of 30–130 mg/day as NO_3 (7–29 mg/day NO_3-N) (International Agency for Research on Cancer, IARC (2010). Because NOC formation is inhibited by ascorbic acid, polyphenols, and other compounds present at high levels in most vegetables, dietary nitrate intake may not result in substantial endogenous NOC formation (International

Agency for Research on Cancer, 2017; Mirvish,1995**).**

Studies of health effects related to nitrate exposure from drinking water were previously reviewed through early 2004 (Ward, Dekok, Levallois, Brender, Gulis, Nolan, Vock ,2012). Furthermore, an International Agency for Research on Cancer (2017) Working Group reviewed human, animal, and mechanistic studies of cancer through mid-2006 and concluded that ingested nitrate and nitrite, under conditions that result in endogenous nitrosation, are probably carcinogenic (International Agency for Research on Cancer, 20107). The determination of the level of nitrates in dug waters could provide updated information on the amount of nitrates deposit in vegetables as a result of using dug water for production. Considering it adverse effect on human health due to exposure

Objectives of the Study

The objective of the study is to over famers the risk involves in the use of shallow dug wells in the production of crops such as vegetables. In specific terms, the object of the study as follows:

1. Determine the level of nitrates deposits in dug water and compare their concentration
2. Determine the level of nitrates in well water used in production(farming) vegetables
3. Determine the level of nitrates in borehole water in the production of vegetables
4. **4.** Determine the level of nitrates in dug water by depth.

Literature Review

With the implementation of the Safe Drinking Water Act in 1974, more than 40 years of monitoring data for public water supplies in the U.S. provide a framework of measurements to support exposure assessments. Historical data for Europe are more limited, but a quadrennial nitrate reporting requirement was implemented as part of the EU Nitrates Directive (European Commission, 2018 & European Union, 1991). In the U.S., the frequency of sampling for nitrate in community water systems is stipulated by their sources (ground versus surface waters) and whether concentrations are below the MCL, and historically, by the size of the population served and vulnerability to nitrate contamination. Therefore, the exposure assessment for study participants who report using a public drinking water source may be based on a variable number of measurements, raising concerns about exposure misclassification. In a study of bladder cancer risk in Iowa, associations were stronger in sensitivity analyses based on more comprehensive measurement data (Vock, 2012). Other studies have restricted analyses to subgroups with more complete or recent measurements (Lindsey & Rupert, 201**2**), with implications for study power and possible selection biases. Sampling frequency also limits the extent to which temporal variation in exposure can be represented within a study population, such as the monthly or trimester-based estimates of exposure most relevant for etiologic investigations of adverse reproductive outcomes. In Denmark, limited seasonal variation in nitrate monitoring data suggested these data would sufficiently capture temporal variation for long-term exposure estimates (Lindsey & Rupert, 2012**).** Studies have often combined regulatory measurements with questionnaire and ancillary data to better characterize individual variation in nitrate exposure, such as to capture changes in water supply characteristics over time or a participant's duration at a drinking water source (Pinnino, Compton & Leibowitz, 2017**).** Most case-control studies of drinking water nitrate and cancer obtained lifetime residence and drinking water source histories, whereas cohort studies typically have collected only the current water source. Many studies lacked information about study participants' water consumption, which may be an important determinant of exposure to drinking water contaminants (VanGrrinsven, Tiktak & Rougoor, 2016).

Due to sparse measurement data, exposures for individuals served by private wells are more difficult to estimate than exposures for those on public water supplies. However, advances in geographic-based modeling efforts that incorporate available measurements, nitrogen inputs, aquifer characteristics, and other data hold promise for this purpose. These models include predictor variables describing land use, nitrogen inputs (fertilizer applications, animal feeding operations), soils, geology, climate, management practices, and other factors at the scale of interest. Nolan and Hitt (2010) and Maupin,Kenny, Hutson,Lovelace, and Linsey (2014) used nonlinear regression models with terms representing nitrogen inputs at the land surface, transport in soils and groundwater, and nitrate removal by processes such as denitrification, to predict groundwater nitrate concentration at the national scale and for North Carolina, respectively. Predictor variables in the models included N fertilizer and manure, agricultural or forested land use, soils, and, in Nolan and Hitt (2010**)** water-use practices and major geology. Nolan and Hitt (2006) reported a training R^2 values of 0.77 for a model of groundwater used mainly for private supplies. Maupin,Kenny, Hutson,Lovelace, and Linsey (2014) reported a cross-validation testing R^2 value of 0.33 for a point-level private well model. These and earlier regression approaches for groundwater nitrate relied on predictor variables describing surficial soils and activities at the land surface, because conditions at depth in the aquifer typically are unknown. Redox conditions in the aquifer and the time since water entered the subsurface (i.e., groundwater age) are two of the most important factors affecting groundwater nitrate, but redox constituents typically are not analyzed, and age is difficult to measure. Even if a well has sufficient data to estimate these conditions, the data must be available for all wells in order to predict water quality in unsampled areas. In most of the above studies, well depth was used as a proxy for age and redox and set to average private or public-supply well depth for prediction.

Recent advances in groundwater nitrate exposure modeling have involved machine-learning methods such as random forest (RF) and boosted regression trees (BRT), along with improved characterization of aquifer conditions at the depth of the well screen (the perforated portion of the well where groundwater intake occurs). Tree-based models do not require data transformation, can fit nonlinear relations, and automatically incorporate interactions among predictors (Howarth, 2011). Wheeler (2015) used RF to estimate private well nitrate levels in Iowa. In addition to land use and soil variables, predictor variables included aquifer characteristics at the depth of the well screen, such as total thickness of fine-grained glacial deposits above the well screen, average and minimum thicknesses of glacial deposits near sampled wells, and horizontal and vertical hydraulic conductivities near the wells. Well depth, landscape features, nitrogen sources, and aquifer characteristics ranked highly in the final model, which explained 77% and 38% of the variation in training and hold-out nitrate data, respectively.

Ransom et al (2017) used BRT to predict nitrate concentration at the depths of private and public-supply wells for the Central Valley, California. The model used as input estimates of groundwater age at the depth of the well screen (from MODFLOW/MODPATH models) and depth-related reducing conditions in the groundwater. These estimates were generated by separate models and were available throughout the aquifer. Other MODFLOW-based predictor variables comprised depth to groundwater, and vertical water fluxes and the percent coarse material in the uppermost part of the aquifer where groundwater flow was simulated by MODFLOW. Redox variables were top-ranked in the final BRT model, which also included land use-based N leaching flux, precipitation, soil characteristics, and the MODFLOW-based variables described above. The final model retained 25 of an initial 145 predictor variables considered, had training and hold-out R^2 values of 0.83 and 0.44 respectively, and was used to produce a 3D visualization of nitrate in the aquifer. These studies show that modeling advances and improved characterization of aquifer conditions at depth are increasing our ability to predict nitrate exposure from drinking water supplied by private wells.

Drinking water nitrate is readily absorbed in the upper gastrointestinal tract and distributed in the human body. When it reaches the salivary glands, it is actively transported from blood into saliva and levels may be up to 20 times higher than in the plasma (Leach,Thompson,& Hill, 2010; Lv, Neal, Ehtsehami, Ninomiya, Woodward, Rodgers, Wang, Macmahon, Turnbull, Hills, 2012; Spiegelhalder, Eisenbrand, Preussmann,2012; & Trick, Kalbel, Preussmann, 2019). In the oral cavity 6–7% of the total nitrate can be reduced to nitrite, predominantly by nitrate-reducing bacteria (Siegelhalder, Eisenbrand, Preussmann, 2012; Eisenbrand, Spieglhhalder, Preussmann, 1980, & Eisenbrand, 1990). The secreted nitrate as well as the nitrite generated in the oral cavity re-enter the gastrointestinal tract when swallowed. Under acidic conditions in the stomach, nitrite can be protonated to nitrous acid (HNO_2), and subsequently yield dinitrogen trioxide (N_2O_3), nitric oxide (NO), and nitrogen dioxide (NO_2). Since the discovery of endogenous NO formation, it has become clear that NO is involved in a wide range of NO-mediated physiological effects. These comprise the regulation of blood pressure and blood flow by mediating vasodilation Ceccatelli, lndberg, Fahrenkrug, Bredt,Synder,Hokfelt, 1992;Moncada,Palmer,Higgs,1991&Rees,Palmer moncada1989) , the maintenance of blood vessel tonus (Palmer, Ferrige & Moncada, 2020), the inhibition of platelet adhesion and aggregation (Radomski, Palmer, Moncada, 2007; Radomski, Palmer,&Moncada, 2008) modulation of mitochondrial function (Larsen,Schiffer,Weitzberg &Lundberg, 2012) and several other processes.

On the other hand, various nitrate and nitrite derived metabolites such as nitrous acid (HNO_2) are powerful nitrosating agents and known to drive the formation of NOC, which are suggested to be the causal agents in many of the nitrate-associated adverse health outcomes. NOC comprise *N*-nitrosamines and *N*-nitrosamides, and may be formed when nitrosating agents encounter *N*-nitrosatable amino acids, which are also from dietary origin. The nitrosation process depends on the reaction mechanisms involved, on the concentration of the compounds involved, the pH of the reaction environment, and further modifying factors, including the presence of catalysts or inhibitors of *N*-nitrosation (Wei,et al, 2003; D'Ischia,et al, 2011; Mirvish,etal, 2015 &Ridd,et al, 2001).

Endogenous nitrosation can also be inhibited, for instance by dietary compounds like vitamin C, which has the capacity to reduce HNO_2 to NO; and alpha-tocopherol or polyphenols, which can reduce nitrite to NO (Eisenbrend, et al,1980; Akuta,et al,2006; Loeppky,et al,1994& Qin,et al,2012). Inhibitory effects on nitrosation have also been described for dietary flavonoids such as quercetin, ferulic and caffeic acid, betel nut extracts, garlic, coffee, and green tea polyphenols (Stich,et al,2014). Earlier studies showed that the intake of 250 mg or 1 g ascorbic acid per day substantially inhibited *N*-nitrosodimethylamine (NDMA) excretion in 25 women consuming a fish meal rich in amines (nitrosatable precursors) for seven days, in combination with drinking water containing nitrate at the acceptable daily intake (ADI) (Vermeer,et al, 2009**).** In addition, strawberries, garlic juice, and kale juice were shown to inhibit NDMA excretion in humans (Chung,et al, 2002**).** The effect of these fruits and vegetables is unlikely to be due solely to ascorbic acid. Using the *N*-nitrosoproline (NPRO) test. Helser et al (2010) found that ascorbic acid only inhibited nitrosamine formation by 24% compared with 41–63% following ingestion of juices (100 mL) made of green pepper, pineapple, strawberry or carrot containing an equal total amount of ascorbic acid.

The protective potential of such dietary inhibitors depends not only on the reaction rates of *N*-nitrosatable precursors and nitrosation inhibitors, but also on their biokinetics, since an effective inhibitor needs to follow gastrointestinal circulation kinetics similar to nitrate **(**Zeilmark,et al, 2010). It has been argued that consumption of some vegetables with high nitrate content, can at least partially inhibit the formation of NOC (Khandelwal,et al; Conforti, et al,2014 & Abraham, etal, 2013**).** This might apply for green leafy vegetables such as spinach and rocket salad, celery or kale (Hesleret al, 2010) as well as other vegetables rich in both nitrate and natural nitrosation inhibitors. Preliminary data show that daily consumption of one bottle of beetroot juice containing 400 mg nitrate (the minimal amount advised for athletes to increase their sports performances) for one day and seven days by 29 young individuals results in an increased urinary excretion of apparent total nitroso compounds (ATNC), an effect that can only be partially inhibited by vitamin C supplements (1 g per day) **(**De Kok, 2018**).**

Also, the number of nitrosatable precursors is a key factor in the formation of NOC. Dietary intakes of red and processed meat are of particular importance **(**Vitousek, Aber, Howarth, Likens, Matson, Schindler, Schlesinger, Tilman,1997) as increased consumption of red meat (600 vs. 60 g/day), but not white meat, was found to cause a three-fold increase in fecal NOC levels. It was demonstrated that heme iron stimulated endogenous nitrosation **(**European Union, 2023) and Hansen, Thorling, Dalgaard, Erlandsen, 2011) thereby providing a possible explanation for the differences in colon cancer risk between red and white meat consumption. The link between meat consumption and colon cancer risk is even stronger for nitrite-preserved processed meat than for fresh meat leading an IARC review to conclude that processed meat is carcinogenic to humans **(**International Agency for Research on Cancer, 2010).

In a human feeding study the replacement of nitrite in processed meat products by natural antioxidants and the impact of drinking water nitrate ingestion is being evaluated in relation to fecal excretion of NOC, accounting for intakes of meat and dietary vitamin C. A pilot study demonstrated that fecal excretion of ATNC increased after participants switched from ingesting drinking water with low nitrate levels to drinking water with nitrate levels at the acceptable daily intake level of 3.7 mg/kg. The 20 volunteers were assigned to a group consuming either 3.75 g/kg body weight (maximum 300 g per day) red processed meat or fresh (unprocessed) white meat. Comparison of the two dietary groups showed that the most pronounced effect of drinking water nitrate was observed in the red processed meat group. No inhibitory effect of vitamin C intake on ATNC levels in feces was found (unpublished results).

Materials and Methods

The study was conducted in Bukuru, Rayfield, Feringada, Bauchi Road, Rikkos Area

Sample Collection and Analysis

Samples were collected with sterilized plastic bottles which was washed severally with the water samples to be collected. Water samples were be filtered through Cotton wool in the first instance and then through whatman No 40 filter paper. 2.0ml of water samples was weighed into a test-tube, followed by 0.02g of magnesium oxide into the same test-tube. Content was then subjected to sun light to evaporated to dryness in a sand-bath at regulated temperature. After evaporation phenoldisulphonic acid method was applied to analysis both samples and respective blanks. Readings (absorbance) was taken at a wavelength of 470nm using the scale mode for water samples. For the food samples, determinations will be carried out by the modified micro-kjeldahl method using the three processes of digestion, distillation and titration**.** In all, 13 samples comprising 10 samples of water and 3 samples of food were collected and analyzed.

Data Presentation and Analysis: The results obtained were tabulated

Table 1: Variation in NO^-_3 Levels with Depth of Boreholes

Sample	Conc. of Nitrate (mg/100ml)	Depth (m)
A1 (Borehole)	16.6	58.30
A2(Borehole)	14.0	58.40
B1 (Well)	21.9	22.87
B2 (Borehole)	15.6	58.35
C1 (Borehole)	21.3	58.10
C2 (Well)	36.5	17.05
D1 (Borehole)	18.6	58.15
D2 (Well)	27.5	15.35
E1 (Borehole)	17.2	58.25
E2 (Well)	29.4	16.35

Table one shows that there is a correlation between the depths of boreholes and nitrate levels. Nitrate levels decreased as the depth of the borehole increased. Also, a correlation between depths of dug wells with nitrate level decreasing with an increase in dug well.

Table 2: Effects of Distance from Septic Tank in Nitrate Concentration

Sample	Conc. of Nitrate (mg/100ml)	Depth (m)
A_1 (Borehole)	16.6	12.35
A_2(Borehole)	14.0	15.40
B_1 (Well)	21.9	9.00
B_2 (Borehole)	15.6	13.35
C_1 (Borehole)	21.3	9.10

C_2 (Well)	36.5	8.00
D_1 (Borehole)	18.6	10.20
D_2 (Well)	27.5	8.70
E_1 (Borehole)	17.2	12.00
E_2 (Well)	29.4	8.0

Table 3: Concentration of Nitrate in Foods Sampled

Sample	Conc. of Nitrate (mg/100ml)
Green Beans	0.98
Garbage	0.7
Carrot	0.1

Discussions of Findings

This study based on the determination of nitrate level in underground waters and some foods has shown that dug wells seems to be the most prone to nitrate contamination. This study showed that wells with high nitrates were those located in close proximity to pit latrines and septic tanks.

The nitrate values in water from the wells are dependent possibly upon the depth, distance from septic tanks and construction of the wells. These wells are usually simple, and primitive, often shallow and unprotected. Thus, they are easily subject to nitrate pollution from the surface, poorly sited tanks and nearby open drains. Dirty plastic containers used as buckets for water collection contributes to the presence of organic materials in the wells and subsequent decomposition, ammonification and nitrification.

The boreholes with high nitrate concentrations are those located in close proximity to the septic tanks. The nitrate values in water from boreholes are possibly dependent upon the depth and construction of the boreholes and also upon their locations.

The level of nitrate contamination in the samples both dug well and drilled boreholes. The nitrate concentrations in the samples are generally below the World Health

Organization (WHO) specified unit of 45mg/I.

The nitrate concentrations in some foods such as green beans, carrot and cabbage. Green beans with high concentration. Probably due to improper fertilizer management which can increase the nitrate level in vegetables. Eighty to ninety percent of the nitrate most people consume comes from vegetables, but it is unlikely to cause health problems because it is converted to nitrate.

The depth of the dug wells and boreholes contributes to the level of nitrate concentration. The effects of distance from nitrate source plays a crucial role in the level of nitrate concentration. A decrease in distance from nitrate source leads to an increase in nitrate concentration in the underground waters. Moreover, Soil washing, storm water in drains, rain water and fresh urine are possible contributors to nitrate levels in the areas studied. Soil washing from a normal area and those under refuse dumps and septic tanks showed variations in nitrate values.

Conclusion and Recommendations

It is recommended that public water should be tested regularly for the presence of nitrate especially for infants, pregnant and lactating mothers. Cases of high nitrate levels should be made known to the appropriate authorities Again proper education on the effects of nitrates has to be carried out. Nitrate sources should be identified and the practice whereby people attempting to remove nitrate in their drinking water sources through boiling need to be discouraged. Water containing high level, of nitrate need to be totally avoided.

Further from the study, it can be deduced that the level of nitrate concentration in underground waters and foods are dependent on the physical and chemical characteristics of the leachates, types of soil, and fertilizers used and method of its fertilizer application, proximity to septic tanks, pit latrines, open drains and depth of the water supply. The government and relevant agencies should rise up to the challenge of preventing the increase in rate of contamination by “Nitrate” in our water supplies. Hand dug wells show considerable amounts of nitrates when they are located close to septic tanks. More intensive and country-wide data are needed to find the various sources of nitrates in country’s underground water and their broad effects over a period of time. There is therefore, an urgent need to introduce routine analysis of water sources for various obvious reasons more especially when it is recommended that pregnant women and infants less than 6 months of age should not in any way make use of any water supply from sources that have nitrate concentration above the World Health Organization (WHO) normal range (45mg/I for Nitrate or 10mg/I for Nitrate-nitrogen).

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