Analysis of Heavy Metals and Organic Pollutants of Ground Water Samples of South Saudi

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Abstract: The groundwater quality was determined in Jazan city southwest of Saudi Arabia, groundwater samples were selected during July 2010 (dry season). Selections of metals which may be toxic in excess when present in drinking water were further discussed (As, Cd, pb, Cu, Cr, Hg, Mn, Ni, Zn, Fe, and Se). Quantitative identification and determination of Total Petroleum Hydrocarbon (TPH), Hydrocarbon C_{10}-C_{40} (diesel hydrocarbon fraction), Volatile Organic Compounds (VOCs), Poly Aromatic Hydrocarbons (PAHs), Total Herbicides and Organochlorine Pesticides in samples based on applications of gas chromatograph (GC). The chemical analysis of groundwater samples show that all samples comply with WHO standards for the parameters measured. Overall the water quality is found to be suitable for drinking purposes without any prior treatment.

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1. Introduction

Water-related diseases are responsible for 80% of all illnesses/deaths in developing countries, and they kill more than 5 million people every year (**UNESCO, 2007**) Water, the precious gift of nature to human being is going to be polluted day by day with increasing urbanization. Although three-forth part of earth is being surrounded by water but a very small portion of it can be used for drinking purposes. Ground water is an important source of drinking water for humankind. It contains over 90% of the fresh water resources and it is an important reserve of good quality water. Ground water, like any other water resource, is not just of public health and economic value(**Armon *et al.,* 1994**). The water pollution by heavy metals has become a question of considerable public and scientific concern in the light of the evidence of their toxicity to human health and biological systems (**Anazawa *et al.,* 2004**). Heavy metals receive particular concern considering their strong toxicity even at low concentrations (**Marcovecchio *et al.,* 2007**). They exist in water in colloidal, particulate and dissolved phases (**Adepoju - Bello *et al.,* 2009**) with their occurrence in water bodies being either of natural origin (e.g. eroded minerals within sediments, leaching of ore deposits and volcanism extruded products) or of anthropogenic origin (i.e. solid waste disposal , industrial or domestic effluents) (**Marcovecchio *et al.,* 2007**). Some of the metals are essential to sustain life-calcium, magnesium, potassium and sodium must be present for normal body functions. Also, cobalt, copper, iron, manganese, molybdenum and zinc are needed at low levels as catalyst for enzyme activities (**Adepoju-Bello *et al.,* 2009**). Lead is a commutative poison and a possible human carcinogen (**Bakare - Odunola, 2005**), while for Mercury, toxicity results in mental disturbance and impairment of speech, hearing, vision and movement (**Hammer and Hammer, 2004**). But growth rate in population compared to olden days, industrialization and hence greater load of wastewater and use of numerous chemicals in industry and agriculture such as insecticides, pesticides, herbicides, hydrocarbons, fertilizers, petroleum products, plastics and polymers etc. have resulted in tremendous build up of organics in many forms in water. Many unexpected organics are reported to be found even in remote parts like hills of Himalayas, Alaska and North Pole due to man-made devastation of our environment. The environmental education has aroused much awareness about the toxicity of traces of environmental pollutants in general and organics in particular. The aim of this study was to investigate the quality of the ground water of the Jazan wells samples in the southwest of K.S.A.

2. Material and Methods:

Sample collection and analysis:

Samples of wells water were collected from two places in dry season (July 2010) from the study area. Before water sampling, all the glass bottles were cleaned and rinsed thoroughly with water to be analyzed.All reagents used were of analytical grade. Samples were unfiltered and the concentration of the different parameters could correspond to the total concentration of the ground water was used by the consumers for drinking. The ground water samples were stored at 1-4°C temperature prior to analysis in the laboratory. Extraction of water samples by liquid-

liquid extraction procedure according to EPA method no. 3510C. Clean-up of organic extract was carried out according to EPA method no. 3600C (**APHA, 2005**).

The apparatus used in the study:

Spectrophotometer Company Hach Lange/LPV 42299–00001. Gas Chromatograph (GC) HP 6890 equipped with ultra 1 HP column (25 m x 0.25 mm x 320 µm. Atomic absorption Spectra AAS Varian 220 equipped with several lamps.

3. Results and Discussions:

In Saudi Arabia, ground water is considered as the first water source for irrigation and other uses. Jazan, figure 1., is located in the southwest of K.S.A, along the red sea cost, the climate of the Jazan can be described as being hot, windy and arid with humidity due to the influence of red sea. The source of drinking water in Jazan city is only ground water. The aim of this study was to investigate the quality of the ground water. Samples were collected during July 2010 (dry season) from the Jazan wells.

Figure 1. Location map of the study area

The ground water from the study area had no color, odor and turbidity. The results of the chemical analysis of ground water from this area are presented in the following Table 1 . So, it is necessary to make a comparison of ground water quality of the study areas with drinking water standards. According to **lode, 1992**, a heavy metal is a chemical element with a specific gravity that at least, 5 times of the specific gravity of water , which is 1.0 at 4°C. However in medicine, heavy metals are loosely defined to include all toxic metals, irrespective of their atomic weight (**John, 2002**). In the light of these definitions, the metals determined in this project work, fall into the heavy or toxic metal category e.g. Iron has a specific gravity of 7.9, Lead = 11.34. In this reference, some of these metals, in tolerable concentrations, are very beneficial to consumers. Iron for example, is made as portion of some multivitamin drugs and products. On the other side, they become toxic when in excess, they are not metabolized by the body and they accumulate in the soft tissues. In cooperation with the U.S Environmental Protection Agency (EPA), the Agency for Toxic Substances and Disease registry (ATDR), has compiled a priority list called the Top 20 hazardous Substance. On this list, Lead (Pb) remains second to arsenic. Lead happens to be the only metal amongst the five, In addition, Lead and Mercury may cause the development of autoimmunity in which a person's immune system attacks its own cells. This can lead to joint diseases and ailment of the kidneys, circulatory system and neurons. At higher concentrations, Lead and Mercury can cause irreversible brain damage (**Lane *et al.*, 2000**). However, excess exposure to heavy metals can cause toxicity. Heavy metal can cause serious health effects with varied symptoms depending on the nature and quantity of the metal ingested (**Adepoju - Bello and Alabi, 2005**). They produce their toxicity by forming complexes with proteins, in which carboxylic acid (–COOH), amine ($–NH_2$), and thiol (–SH) groups are involved. These modified biological molecules lose their ability to function properly and result in the malfunction or death of the cells. When metals bind to these groups, they inactivate important enzyme systems or affect protein structure, which is linked to the catalytic properties of enzymes. This type of toxin may also cause the formation of radicals which are dangerous chemicals that cause the oxidation of biological molecules. The most common heavy metals that humans are exposed to are Aluminium, Arsenic, Cadmium, Lead and Mercury. Aluminium has been associated with Alzheimer's and Parkinson's disease, senility and presenile dementia. Arsenic exposure can cause among other illness or symptoms cancer, abdominal pain and skin lesions. Cadmium exposure produces kidney damage and hypertension.

The concentrations of all target elements are summarized in Table 1. The concentration level ranged from 0.0001mg/l to 0.01 mg/l. There was no detectable heavy metal in the wells water. For the protection of human health, guidelines for the presence of heavy metals in wells water have been set by different International Organizations such as USEPA, WHO, EPA, European Union Commission (**Marcovecchio *et al.*, 2007**), thus, heavy metals have maximum permissible level in water as specified by these organizations. Maximum contaminant level (MCL) is an enforceable standard set at a numerical value with an adequate margin of safety to ensure no adverse effect on human health. It is the highest level of a contaminant that is allowed in a water system.

(**WHO, 2000; Hammer and Hammer , 2004**).

Table 1 gives the summary of the results obtained in this study for concentrations of the major metals in the wells water.

Table 1: Major metal concentration in ground water samples

Elements	Unit	Mean of concentration
As	mg/l	<0.001
Cd	mg/l	<0.0001
Pb	mg/l	<0.0001
Cu	mg/l	<0.01
Cr	mg/l	<0.002
Hg	mg/l	<0.0005
Mn	mg/l	<0.01
Ni	mg/l	<0.001
Zn	mg/l	<0.005
Fe	mg/l	<0.01
Se	mg/l	<0.002

Pesticides consist of a large group of chemicals that are used in agriculture and residential settings to control plant and animal infestation. The use of synthetic organic pesticides has grown rapidly since the 1950s because, when used in conjunction with fertilizers, they increase crop yields. Pesticides are, however, a risk to human health. In the case of a pesticide spill or misapplication near a well, the levels of pesticides in drinking water may reach high enough levels to cause immediate health problems, such as the damage of the nervous system, some pesticides can cause cancer; some can also result in birth defects, Thyroid Changes, Nervous System Effects, Blood Changes, Kidney and Liver Changes. Maximum Contaminant Levels (MCLs) have been established by the USEPA and NJDEP for many pesticides. MCLs are set at levels well below those known to cause harmful health effects. MCLs are limits that public water systems are required to meet by law. For most pesticides, In addition, USEPA has issued Health Advisories for many pesticides.

Table 2. Show that by using standards USEPA and NJDEP all of the wells water samples within the optimum value. This would indicate that most wells are suitable to use as drinking water.

Table 2. Results of pesticides in wells water samples.

Parameter	Water sample
Monocrotopho	47.4 ng/l
Bioaltherin	286.2 ng/l
Primiphose	287.04 ng/l
Pyrozophose	666.2 ng/l
Fenthion	ND
Permethrine	ND
Total	1286.84

ND: less than detection limit.

One of the best known classes of ground water contaminants includes petroleum-based fuels such as gasoline and diesel. Nationally, the U.S. Environmental Protection Agency (EPA) has recorded that there have been over 400,000 confirmed releases of petroleum-based fuels from leaking underground storage tanks. Gasoline consists of a mixture of various hydrocarbon that dissolve to some extant in water, and often are toxic. Table 3 shows that Using standards USEPA all of the wells water samples within the acceptable limits. This would indicate that most wells are suitable to be used as drinking water.

Table 3. Organic results of wells water samples.

Parameters	Water sample
Total Petroleum Hydrocarbon (TPH)	230.41ug/l
Hydrocarbon C_{10}-C_{40} (diesel Hydrocarbon fraction)	144.59 ug/l
Poly aromatic Hydrocarbons (PAHs)	ND
Volatile Organic Compounds (VOCs)	ND
Total Herbicides	ND
Organochlorine Pesticides	ND

ND: less than detection limit

Conclusion

Drinking water can be obtained from a number of sources, the one used often depending on the relative availability of surface water (such as rivers, lakes, and reservoirs) and ground water aquifers). In Jazan southwest Saudi ground water from wells is an important source of drinking water. However, in some cases ground water may contain chemical constituents hazardous to the health. This research give the summary of the results obtained in this study for concentrations of heavy metals level ranged from 0.0001mg/l to 0.01 mg/l. There was no detectable of heavy metal in the wells water. Both Pesticides and organic compound in wells water were within the optimum value using standards USEPA. It means that water is not polluted. This would indicate that most wells are suitable to be used as drinking water source. However, regular monitoring should be ensured by the authorities concerned.

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