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ASSAY OF CHEMICAL ANALYSIS AND BACTERIOLOGICAL EXAMINATION OF GROUND WATER IN GIZA AND KALUOBIA GOVERNORATES WITH SPECIAL REFERENCE TO HEAVY METALS

By

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ABSTRACT

Hundred twenty six ground water samples from fourty two wells comprising different depths. Ten wells at less than 15 m. depth; twelve deeper wells between 15 and 30 m. depth; and deepest wells more than 30 m. depth. These wells were found at various localities in Giza and Kaluobia governorates. These wells were examined chemically and bacteriologically. From the obtained data, it was found that the observed values or concentrations of cadmium, nitrate and phosphate above the maximum desirable limits specified by world Health organization (WHO) for use as drinking in 35.71,33.33 and 26.19 % of totally examined wells respectively. Whereas, fecal coliform. Streptococcus faecalis, chloride and copper polluted wells were found to be at a percentage 16.66, 7.14, 4.76 and 4.76%. However, the pollution with ammonia, sulphate, irons and lead was found to be within the permissible limits. The shallow wells (up to 15m.depth) were examined. The percentage of polluted wells was found to be highest with cadmium, then phosphate, faecal coliform, copper and streptococcus faecalis at a Percentage of 60, 50,50, 20 and 20% respectively. However. In the moderately deep wells (> 15 to 30m depth) the percentage of polluted wells was found to be mainly from nitrate. Then cadmium, phosphate, fecal coliform fecal streptococci and chloride with a percentage of 66, 50. 50, 16, 8 and 8% respectively. On the other hand, in the deep wells (>30m to 50 m depth), the percentage of polluted wells was the least, the percentage of polluted wells with nitrate and cadmium was found to be 30 and 15% of the 20 examined wells respectively. The hygienic significance as well as sanitary measures suggested for prevention of chemical and bacterial pollution of ground water was discussed.

INTRODUCTION

Ground water is considered as an important source to be used in animal and poultry farms. The essentiality for the protection of such source against pollution-contamination is of almost importance. Consequently, the groundwater source should be as remote as possible from any source of pollution, such as latrines, septic tanks, sewage discharges agriculture drainage water discharges, etc. The direction of groundwater flow should be known to ensure that no pollution source are situated directly upstream of abstraction point (**McGhee, 1991**). Groundwater has been considered a safe water source for drinking due to its protection against surface contamination. However, a number of reports about chemical and microbiological contamination have disproved this assumption. (**Dott *et al.*, 1986**). The quality of groundwater was subjected to a number of chemical threats. There were many possible sources of chemical pollution. The quality of ground water was subjected to a number of threats. There were many possible source of chemical pollution such as wastes, from industrial chemical production, metal plating operations, pesticides from agricultural lands, beside other specific pollutants such as heavy metals including cadmium, lead, chlorinated hydrocarbons, industrial wastes. Also, ground water is liable for bacterial contamination especially coliform organisms. Heavy metals include essential elements like iron as well as toxic metals like cadmium. Most of them had a tremendous affinity for sulphur and disrupt enzyme function by forming bonds with sulphur groups in enzymes. Cadmium, copper and lead ions bind to cell membranes, hindering transport processes through the cell wall (**Manahan, 1994**).The coliform organisms are the most commonly measured indicators of water quality. Total coliforms are defined as gram negative bacteria that ferment lactose at 35 or 37 °c, with the production of acid, gas and aldehyde within 24- 48 hours fecal coliforms (thermotolerant coliforms) are a subgroup of total coliforms, having the same properties except that they tolerate and grow at the higher temperature of 40 – 44 °c, and form indole from tryptophan, organisms possessing these combined, properties are regarded as presumptive Escherichia coli. The total coliform group includes several genera, all of which may be of faecal origin. Under suitable conditions these could multiply in the presence of organic material. Some coliform species are frequently associated with plant debris or may be common inhabitation in soil or surface water. Thus, the total coliform group should not be regarded as an indicator of organisms exclusively of faecal origin, especially in very hot countries where coliforms of non- – faecal origin may observed. The use of total coliform as an indicator may be of value for deep well water. However, it may be of little value in assessing the faecal contamination of surface water and especially of water in unprotected shallow wells, where contamination by coliform of non-faecal origin can often readily occur. Ideally a drinking- water supply should be free of faecal coliform; the faecal streptococci include other species that may multiply in soil and surface water, especially in combination with plant debris, decay material. The streptococci of fecal origin have, However a longer survival time in groundwater than faecal coliforms (**WHO, 1985**).

The main objectives of this study are to judge the hygienic fitness and quality of well water in relation to their depth in Giza and Kalubia governorates.

MATERIAL AND METHODS

Sampling:

One hundred twenty of water samples were collected from 42 wells distributed at various localities in Giza and Kaluobia governorates. These examined wells were classified into three groups according to their depth, the first group (up to 15 meter depth), the second group (> 15 to 30 meter depth), the third group (> 30 to 50 meter depth). The depth of water wells was known through questionnaire of the owners. The classification of well depth was done according to **Abd El-Aal and Khalaf-Allah, (1999)**. Every tested well was pumped for about 15 minutes except in case of lead examination that need keeping closed overnight in order to obtain representative water sample. The samples were collected under aseptic conditions in sterile transparent labeled glass bottles provided with glass stopper of 2 liter capacity .The samples were dispatched to the laboratory in suitable insulated boxes with a minimum of delay for both chemical analysis and bacteriological examination.

Determination of chemical elements and heavy metals was done according to **Fresenius *et al.,* (1988**). Bacteriological examination which included total colony count, typical coliform count and faecal streptoccal count was performed according to **A.P.H.A (1976)** and **Cruckshank *et al.,* (1980)** in case of fecal streptococcal count.

RESULTS AND DISCUSSION

Chemical elements:

The results revealed that ammonia; phosphate, chloride and sulphates were found to be within the permissible limits in the deepest and shallowest wells. Whereas, in case of the less deep wells, ammonia and sulphates were within the allowed limits (table I). Ammonia was the initial product of decay of nitrogenous organic wastes. Its presence frequently indicates the presence of such wastes. It was found to be with highest level in shallowest wells. Its concentrations ranged between 0 and 0.476 PPM with a mean of 0.0841 PPM. The concentrations were decreased in the deeper wells as became ranged between 0 and 0.143 PPM with a mean of 0.0271 PPM. While in the deepest wells, concentrations were much decreased ranged between 0 and 0.032 PPM with a mean of 0.0087 PPM. Similar findings were obtained by **Abd El -Aal and Khalaf-Allah, (1999)**. Highest figures were observed by **Abd El-karim *et al.*, (1993),** They reported that the concentration of ammonia was low in the groundwater. Mean of total wells was found to be 0.0319 PPM. The concentration of sulphate in all wells was found to be within the permissible limit. Hygienic significance was in addition to water hardness, associated with magnesium or sodium, a pronounced laxative effect on people who were not accustomed to such water. The concentrations were ranged between 100 and 200, 0 and 100, and 0 and 100 PPM in shallow, deep, and deepest wells respectively. The mean levels were found to be 150,33.33.42.5 and 65.4875 PPM in shallow, deep, deepest and total wells. Chloride in high concentration could contribute a salty taste to water and may indicated sewage contamination, since the chloride concentration increased when water was used for domestic purposes. The percentage of polluted wells was found to be 4.76% with a total mean of 91.667 PPM. The polluted wells were from the moderately deep wells with a percentage of 8% and a mean of 204.166 PPM. Shallow wells came second with a mean of 110PPM. Lastly the deepest wells, with a mean reached 15 PPM only. This result did not differ greatly with the results obtained by **Abd El-Aal and Khalaf-Allah, (1999)**. They found more pollution in the shallowest wells. While **Abd El-Karim *et al.*, (1993)** found a higher level of chloride. Phosphate is a constituent of soil and was used extensively in fertilizer to replace and /or supplement natural quantities on agricultural lands. It was also a constituent of animal waste and may become incorporated into the soil in grazing and feeding areas. Runoff from agricultural areas was a major contributor to phosphate in surface wastes. The tendency for phosphate to absorb to soil particles limits its movement in soil moisture and groundwater, but results in its transport into surface water by erosion. While phosphates were not toxic and not represent a direct health threat to human and animals, could interfere with water treatment processes. Concentrations as well as 0.2PPM interfere with the chemical coagulation of turbidity. In this study, this salt with a mean of 0.215 and 0.16125 polluted 50% of shallow and moderately deep wells respectively. The natural oxidation of nitrite to nitrate occurs quickly so that significant quantities of nitrite are not found in natural water (**Peavy *et al.*, 1985**). Other sources of nitrogen in aquatic systems include animal wastes, chemical (particularly chemical fertilizers), and wastewater discharges. Nitrogen compounds can be oxidized to nitrate by soil bacteria and may be carried into the groundwater by percolating water. Once in the aquifer, nitrates moved freely with the groundwater flow. Groundwater contamination by nitrogen from animal feedlots and septic tank drain field had been recorded in numerous instances. Nitrate poisoning in infant animals, including human, could cause serious problems and even death. The lower acidity in the intestinal tract of infant, permits growth of nitrate- reducing bacteria. That converts the nitrate to nitrite, which is then absorbed into the bloodstream. Nitrite had a greater affinity for haemoglobin than did oxygen and then replaced oxygen in the blood complex. The body was denied essential oxygen and, in extreme cases, the victim suffocated. Because oxygen starvation resulted in a bluish discoloration of the body, nitrate poisoning had been referred to as the blue baby syndrome. Although, the correct term is methemoglobinemia. Once the flora of the intestinal tract had fully developed, usually after the age of 6 months, nitrate conversion to nitrite and subsequent methemoglobinemia from drinking water is seldom a problem (**Peavy *et al.,* 1985**).

Nitrates were found to be responsible for the pollution in 33.33% of total wells with a mean of 3.1821 PPM. The highest percentage was found to be in moderately deep wells (66% with a mean reached 5.12PPM). The deepest wells came next at a percentage of 30% and a mean of 1.30 PPM. The shallowest wells had a mean concentration of nitrate 4.56 PPM and all of them within allowed limits. These findings in accord with the results described by (**Muller *et al.,* 1995; Wojcik *et al.,* 1996; Abd El –Aal and Khalaf-Allah, 1999 and Kitty Gelberg *et al.,* 1999**) as they observed the same arrangement. Higher levels described by **Teraoka, (1993).** A wide range was reported by **Abdel-Karim, (1993).** A much more concentrations (80PPM) reported by **Massone *et al.,* (1998).** 11% of all wells in New York exceed the maximum contaminate limit (**NYSDOH, 1993;Federal Register, 1993).** Other health concerns from nitrate include cancer and spontaneous abortion. A study in Spain found increased mortality rates from gastric and prostate cancer with increasing exposure to nitrates in the drinking water (**Morales-Suarez –Varela *et al.*,** 1995). Levels as low as 73 PPM had been detected in drinking water associated with naturally occurring nitrate toxicity in ruminants (**Osweiller *et al.,* 1985**). The solution for dealing with a high nitrate problem is constructing a new well and correcting the source of contamination as the removal of nitrates from the water can be complicated and expensive. (**Kitty Gelberg *et al.,* 1999).**

Heavy metals:

Cadmium is cumulative poison (**Commission of the European Communities, 1978**). Cadmium had a significant role in the incidence of some diseases e.g. diabetes mellitus (**Merali and Singhal, 1977**): chronic renal failure (**Friberg *et al.,* 1986**), human hypertension (**Nishyama *et al.,* 1986**) and anemia (**Watanabe and Murayama, 1974).** In animals, cadmium toxicity induced anemia and nephrogenic hypertension as well as teratogenesis (**Landis and yu, 1995**); Hepatic necrosis (**Anderson, 1989**) and atherosclerosis (**Vodela *et al.*, 1997**). Cadmium pollution of the environment is increasing because this metal is used in the manufacture of plastics, solder alleys, nickel cadmium batteries, photo cells, rubber tires and many other items (**Booth and McDonald, 1982**). In this work, the highest percentage of pollution was found to be from this metal 35.71% with a mean of 0.1895 PPM.The highest pollution was found to be in the shallow wells (60% and a mean of 0.777PPM), then in the moderately deep wells (50% with a mean of 0.0011 PPM) and lastly the deepest (15% and a mean level of 0.001 PPM). Higher pollution (0.03 PPM at 64 m. depth) was observed by (**Abdel-Kader, 1994**). Copper was the second in percentage of pollution as it reached to 4.76% of total wells; the polluted wells were only the shallow group with a percentage of 20% and a mean of 0.457 PPM .The mean level in the moderately deep wells was found to be 0.449916 PPM. Whereas, in the deepest wells was 0.01159 PPM. The same arrangement and lower levels was reported by (**Abd El-Aal and Khalaf-Allah, 1999**). Higher levels reported by (**Tork, 1989**) and extremely much level observed in springs by (**Zabugina *et al.*, 1964**). Acute exposure to copper cause hypotension, haemolytic anaemia and cardiovascular collapse, while chronic exposure resulted in jundice in human (**Gossel and Bricker, 1990**). Iron contributed to hardness, but its more important effect result from its oxidation and subsequent precipitation. This caused metallic tastes and discoloured water, which stain clothes, cooking utensils and plumbing fixtures. The levels of iron in all wells were found to be within allowable limits. The mean levels decreased with the increase of depth; the mean levels were 0.33, 0.27 and 0.22 in the shallow, deep and deepest wells respectively. These findings in accord with that reported by (**Abd El-Aal and Khalaf –Allah, 1999**). Higher levels reported by (**Tork, 1989 and Zabugina *et al.*, 1964**). Lead widely distributed as metallic lead, inorganic compound, and organometallic compounds, had a number of toxic effects, including inhibition of the synthesis of hemoglobin. It also adversely affects the central and peripheral nervous systems and the kidneys. Acute lead poisoning in humans caused severe dysfunction in the kidneys, reproductive system, liver, and the brain. The result was sickness or death. Lead poisoning from environmental exposure was thought to have caused mental retardation in many children. Mild lead poisoning caused anemia, the victim may had headaches and sore muscles and may feel generally fatigued and irritable (**Manhan, 1994**). Chronic lead poisoning was characterized by neurological defects, renal tubular dysfunction and anemia (**Underwood, 1977**). Its potential carcinogenic nature had also been shown by (**Zawurska and Medras, 1988**). Anorexia and weight loss occurred in human exposed to drinking water containing lead levels of 40 to 200 PPM (**Pagliuca *et al.*, 1990 and Schneitzer *et al.*, 1990**). The mechanism by which lead induced anorexia was not well understood. **Koller and Kovacic, (1974)** reported immune suppression in mice exposed to (13.75ppm) lead acetate in drinking water. The presence of lead in drinking water could have contributed to impaired egg production through the suppression of calcium metabolism (**Vodela *et al.*, 1997 b**). The mean level of lead in this study was found to be 0.0019 PPM. The mean levels were 0.0011,0.0009 and 0.003 PPM in the shallow, moderately deep and deep wells respectively. Moreover all water of the wells contain lead within permissible limits. Our findings were less than those reported by (**Abd El-Aal and Khalaf- Allah, 1999;Zabugina *et al.*, 1964 and Tork, 1989**).

Bacterial count:

Direct enumeration of enteric pathogens in water was time consuming and ineffective and not a sensitive means to protect the public health (**AWWA, 1994; Cherry *et al.*, 1972 and WHO, 1993**). Moreover, there was no battery of laboratory tests that could detect every individual pathogen. Faecal coliform methods typically enumerate Klebsiella spp., Enterobacter spp., and Escherichia spp. (**Bagley and Seidler, 1977; Caplenas aud Kanarek, 1984 and USEPA, 1986**). In the present study the percentage of polluted wells with faecal coliform was found to be 16.66% with a mean of 0.4 colony/ 100 ml .The shallow wells had the highest percentage 50% and mean 1.5 colonies per 100ml. Moderately deep wells had a less percentage 16% lower mean 0.25 colonies per 100ml.Faecal coliforms were detected in 60% of the wells that examined by (**Massone, *et al.*, 1998**). Concerning Streptococcus faecalis; the percentage of polluted wells was found to be 7.14% with a mean of 0.09 colonies per 100ml. Shallow wells had the highest percentage 20% and also the highest mean 0.3 colonies per 100ml of water. The moderately deep wells had 8% polluted wells and mean reached 0.08 colonies per 100ml water. No bacterium could be cached in deepest well group. These findings in agree with those of (**Abd El-Aal and Khalaf – Allah, 1999**).

So, the conclusion of this work is The deeper the well, the more hygienic will .The dangerous aspect is the increased levels of nitrate and cadmium in Giza and Kaluobia Governorates.

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Table (1) Level of pollutants and Percentage of polluted wells at different depth

	Pollutants	Well depth (up to 15m)			Well depth (> 15-30)			Well depth (> 30-50m)			Mean of pollutant in all wells	Percentage of polluted wells	WHO permissible limits (1984)
		Range	Mean ± SE	% of polluted wells	Range	Mean ± SE	% of polluted wells	Range	Mean ± SE	% of polluted wells			
Chemical Elements (PPM)	Ammonia	0 –0.476	0.0641 0.007	0	0.143	0.0271 0.001	0	0-0.0132	0.0087 0.0001	0	0.0319	0	0.5
	Nitrate	0 - 14.5	4.56 0.352	0	0-16.4	5.12 0.42	66	0-3.6	1.30 0.11	30	3.1821	33.33	10
	Phosphate	0 - 0.43	0.215 0.03	50	0-0.43	0.1612 0.001	50	0-0	0 0	0	0.5588	26.19	0.2
	Chloride	0-200	110 12.4	0	100-500	204.167 19.251	8	0- 100	15 [illegible] 342	0	91.667	4.76	250
	Sulfate	100 – 200	150 17.3	0	0-100	37.333 3.215	0	0-100	42.5 3.654	0	65.4875	0	250
Heavy Metals(PPM) PPM)	Cadmium	0- 2.357	[illegible] 0.06	60	0-0.052	0011 0.0001	50	0 -0.0019	0.001 0.0001	15	0.1895	35.71	0.005
	Copper	0.082- 1.33	0.457 0.05	20	0.0099 1.33	0.4499 0.0345	0	0.0043- 0.078	0.0115 0.002	0	0.1378	4.76	1
	Iron	0.19- 0.75	0.33 0.0	0	0.12- 0.56	0.27 0.015	0	0.09- 0.44	0.22 0.012	0	0.1910	0	0.3
	Lead	0-0.0098	0.0013 0.0001	0	0-0.0075	0.0009 0.0001	0	0-0.0033	0.003 0.001	0	0.0019	0	0.05
Bacterial Count Colonies /100ml water	**Faecal coliform**	0 – 5	1.5 0.16	50	0-2	0.25 0.02	16	0-0	0 0	0	0.4285	16.66	Max5 Aver1
	Strept. faecalis	0-2	0.3 0.03	20	[illegible]	0.08 0.007	8	0-0	0 0	0	0.0952	7.14	0

الملخص العربي

تقدير المعادن الثقيلة والتحليل الكيميائى والبكتيرى للمياة الجوفية بمحافظتى الجيزة والقليوبية

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**** قسم الصحة والطب الوقائى بكلية الطب البيطرى بكفر الشيخ - جامعة طنطا**

تم الاختبار الكيمائى والبكتيرى لـ ١٢٦ عينة مياه جوفية من ٤٢ بئراً قسمت لثلاث مجموعات حسب عمقها هى ١٠ آبار فى أعماق حتى ١٥ متراً و١٢ بئراً أكثر من ١٥ متراً إلى أقل من ٣٠ متراً والمجموعة الثالثة آبار أكثر من ٣٠ وحتى ٥٠ متراً فى مناطق مختلفة بمحافظتى الجيزة والقليوبية .

وقد وجد ارتفاع عن النسب المحددة من قبل منظمة الصحة العالمية عام ١٩٨٤م فى الكادميوم والنترات والفوسفات وكانت نسبة الآبار الملوثة على التوالى بهذه الكيماويات ٣٥,٧١ % و ٣٣.٣٣ %و ٢٦,١٩ % أما نسب الآبار الملوثة بالميكروبات القولونية والميكروب السبحى القولونى وأملاح الكلوريد ومعدن النحاس فعلى التوالى (١٦,٦٦ %و ٧,١٤ %و ٤,٦٧ %و ٤,٦٧ %) أما معدلات التلوث بالآمونيا والكبريتات ومعادن الحديد والرصاص فكانت فى المستويات المسموح بها .

أما مشاكل الآبار فى الأعماق (حتى ١٥ متراً) فهى التلوث بالكادميوم ثم الفوسفات فالميكروبات القولونية فالنحاس والميكروب السبحى القولونى بنسب (٦٠ %و ٥٠ %و ٥٠ %و ٢٠ % ٢٠ % من الآبار) أما مشاكل الآبار فى أعماق ما بين (فوق الـ ١٥ حتى ٣٠ متر) فالنترات ٦٦ % والكادميوم ٥٠ % والفوسفات ٥٠ % والميكروبات القولونية ١٦ % والميكروب السبحى القولونى ٨ % وأملاح الكلوريد ٨ % .

أما الآبار العميقة (ما بين ٣٠ وحتى ٥٠ متراً) فكانت الآبار الملوثة بالنترات ٣٠ % والكادميوم ١٥ % .