JCBPS; Section D; February 2018 – April - 2018, Vol. 8, No.2; 076-083. E- ISSN: 2249 –1929
[DOI: 10.24214/jcbps.D.8.2.07683.]

Journal of Chemical, Biological and Physical Sciences

An International Peer Review E-3 Journal of Sciences

*Available online at*www.jcbsc.org

*Section D: Environmental Sciences*

CODEN (USA): JCBPAT Research Article

# Regular Assessment of Groundwater to Assist Health and Economic Development in Saudi Society, "VISION 2030 G", Taif, KSA

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**Received:** 06 February 2018**; Revised:** 16 February 2018; **Accepted:** 26 February 2018

**Abstract:** This paper was for confirm "Regular assessment of groundwater (GW) to assist health and economic development in Saudi Society (SS), "VISION 2030 G", Taif, KSA", highest turbidity were in GW samples (3, 6 and 10), all samples had pH values falling standards. Electric Conductivity (EC) revealed 20% samples were above standards. The salinity was considered unsuitable for drinking samples (3, 4 and 10), Total Hardness (TH) was high in samples (3, 4 and 10). Calcium Carbonate ($CaCO_3$) ranged (55-2793) mg $L^{-1}$ in 30%, Chlorides ($Cl^-$) ranged (18-1759) mg $L^{-1}$ in 30%, Sulfates ($SO_4^{2-}$) ranged (33-2245) mg $L^{-1}$ in 90%, Nitrates ($NO_3^-$) ranged (0-60) mg $L^{-1}$ in 80% of GW samples. The bacteria were present in all GW samples except sample 2, one bacterial type was in sample 3, and others had two types. Gram positive bacteria found in all except sample 3, either joined Gram negative samples except samples (1, 2, 3, 6 and 7). The colony count were ranged ($1.5X10^3$-$5.5X10^4$) CFU/mL. The bacteria of Gram positive were (*Staph. spp* and *Micrococcus spp*) and Gram negative were (*E. coli* and *Klebsiella spp*). That concluded the variations in GW samples with standards, that need foxed in uses or treatment. The presence of faecal contamination can cause infection and food poisoning or toxic production that will affect SS. The recommendation is to "MOH and MOIAL", to regular follow up

GW quality at high altitude (HA) area using for "human, animal, birds and plant resources" to protect the community health (CH) and helping SS.
**Keywords**: GW, SS, pH, EC, TH, TH.

## 1. INTRODUCTION

GW chemical quality showed wide variation among the samples with TDS, all GW samples had pH falling within standards limits[1]. The taste and odour ranged (2-3) as TON, the range (0.11-0.79 NTU) turbidity was recorded in E-Makkah, was High pH 8.44, EC (7,735.36 ds/m) in N-Makkah, low pH 6.62 in NW-Makkah and low EC 115.61ds/m in E-Makkah[2]. The turbidity was 0.6 NTU within the desirable limit of 5 NTU, the distribution of Na value for total alkalinity[3]. The total nitrogen and organic carbon ranged (15.21-61.33) mg/l and (10.63-70.60) mg/l, which exceeded the Mo-WE standards for total ammonia and nitrate[3].

GW bacterial quality resulted in Al-khamis, total *Coliform* count was 100%, faecal *Coliforms* 87.9% and *Strept. spp* 57.6%[4]. In Hail, were found faecal contamination by *Coliform* bacteria 20%[1], in Makkah, found *E. coli*[2], *Acinetobacter* (1.5- 48%) and *Pseudomonas aeruginosa* ($9.55\times10^{-4}$)[5].

The aim of this paper was for confirm the regular assessment of GW to assist health and economic development in SS, "VISION 2030 G", Taif, KSA. GW in KSA known as a precious and extremely needed for SS, it should be regularly assessed to benefit and support the Saudi economy. It considered one of the priorities of research to GW in HA areas in order to ensure the difference than normal altitude (NA) area for helping SS and economy. Continuous assessment of GW quality as routine basis which extremely needed, it is imperative to reduce the deterioration of GW quality and eliminate health problems.

## 2. MATERIALS AND METHODS

- **Location map:** The available GW sources at Taif area were chosen after their owners agreement (map 1)[6].
- **Collection samples:** All GW samples were obtained in sterile polyethylene bottles and were taken to Lab.[7].


***Map 1: the location of GW samples collected from Taif area***

- **Analysis methods:**

**Physical:** That were done according to (S.A.S.O., G.C.C.S. and WHO)[8], turbidity was determined by Spectro-photo-meter, EC (dS m−1 at 25 ◦C) and TDS were measured by digital conductivity meters (Digital conductivity [HI9636] Micro-processor conductivity and TDS)[9].

**Chemical:** That were included pH was done by (HANNA pH 211Micro-processor-meter), (TH, Calcium Ca2+ and Magnesium Mg2+) were determined by titration with EDTA–disodium salt solution (0.01 N). Chlorides Cl− were determined by titration using standard silver nitrate solution and potassium chromate, (5% solution) as an indicator. Nitrate (NO-1) and sulfate (SO-2 4) were determined by colour development and UV-Visible Spectro-metric measurements of absorbance[10].

**Bacterial:** The sterile GW samples were passed on an ideal bacterial isolation and identification methods[11].

- **Data analysis:** All data and results were analyzed by Simple Excel Methods[12].

## 3. RESULTS AND DISCUSSION

All GW samples were collected from different area in Taif area, the wells were rocky in nature. GW samples (3, 4 and 10) were for agriculture irrigation and the others for human drinking.

***Table 1: Prevalence of physical characters***

| *Samples K *No.* | *Turbidity* | **pH* | **EC* | **TDS* |
|---|---|---|---|---|
| ***K1*** | *0.007* | *6.5* | *2.7* | *144* |
| ***K2*** | *0.001* | *6.8* | *2.8* | *122* |
| ***K3*** | *0.030* | *6.6* | *69.1* | *1460* |
| ***K4*** | *0.002* | *6.8* | *25.7* | *246* |
| ***K5*** | *0.008* | *5.7* | *3.6* | *144* |
| ***K6*** | *0.040* | *5.7* | *4.0* | *145* |
| ***K7*** | *0.015* | *6.0* | *3.5* | *137* |
| ***K8*** | *0.006* | *5.8* | *3.8* | *142* |
| ***K9*** | *0.011* | *5.7* | *3.7* | *139* |
| ***K10*** | *0.018* | *6.9* | *143* | *11460* |
| ***No.: Number, *pH: Potential of Hydrogen, *EC: Electric Conductivity, *TDS: Total Dissolved Salts*** | | | | |

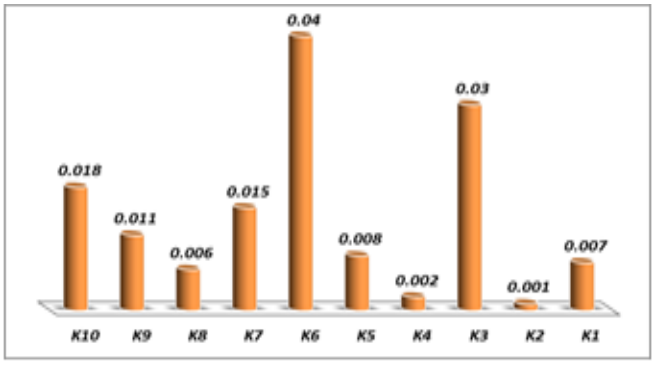


***Fig.1: Prevalence of turbidity***

Table 1 and figure (1, 2, 3 and 4) showed prevalence of physical characters, GW was moving through underground media as (rocks and soils) and these effected in their quality and characters. It is necessary to make a comparison of GW quality of the under study areas according to drinking water standards. Table and figure 1 showed prevalence of turbidity, GW samples contained turbidity, that indicated the presence of microbial contamination, were read all higher than "Gold Standard Zero". The highest turbidity GW samples were (3, 6 and 10), were read (0.04, 0.03 and 0.018) respectively. The presence of turbidity was largest evidence of faecal microbial contamination and others, this

alarm bell that proved the existence of very harmful microbial effect might cause microbial infection or poisoning[1-3].

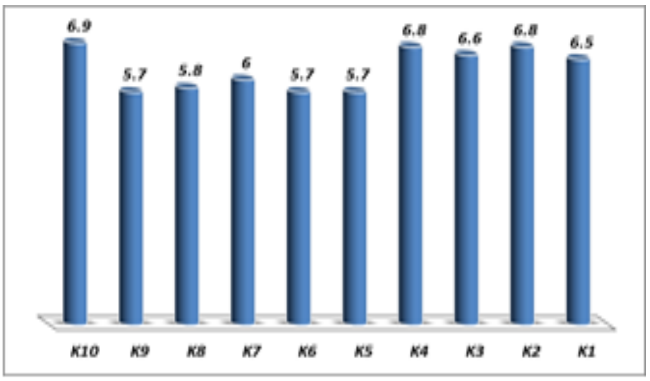


***Fig.2: Prevalence of pH***

Table 1 and figure 2 showed prevalence of pH, GW samples with exception of guideline limit for pH (pH < 8)[11], all GW samples had pH values falling within the limits of the respective standards included the range (5.7-6.9)[1-3].

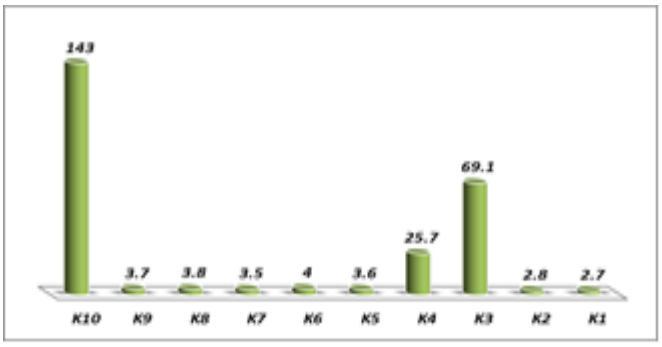


***Fig.3: Prevalence of EC***

Table 1 and Figure 3 showed prevalence of EC that were a wide variation in concentration direct measurement was potentially a very sensitive procedure for measuring ionic concentrations. The average value for was 1552 micro-mohs and it was ranging from (122-1460) micro-mohs.

Saudi Arabian Specifications and Measurements Agency[8-10] states, that the optimum value for the EC was 800 micro-mohs, the maximum allowable value was 2300 micro-mohs. Using this standard, all GW samples were within the optimum value.

WHO standards[8-10] recommendation for EC was only 1400 micro-mohs, so EC in all GW samples were not exceeded the maximum allowable value in WHO limits[8-10]. EC was a decisive parameter in determining suitability of water according to EC, that for salinity of drinking water that revealed 20% of GW samples were above the limits of (SASO, G.C.C.S., WHO and USEPA)[1-3, 8-10].

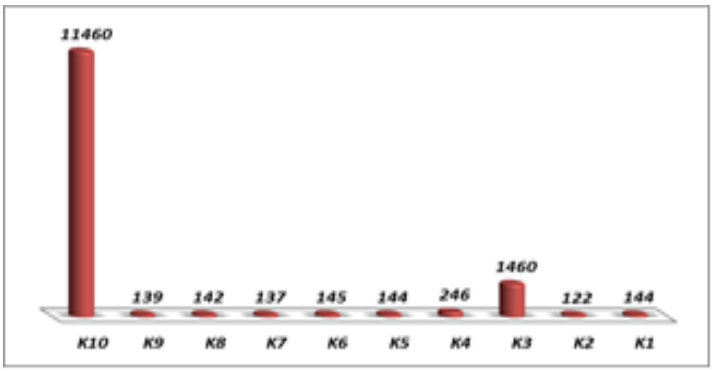


***Fig.4: Prevalence of TDS***

Table 1 and figure 4 showed TDS, GW samples was lowest value recorded for drinking water whereas the highest value was recorded for GW samples used for irrigation[1-3].

***Table 2: Prevalence of chemical quality***

| *Parameters* | *Range* | *SASO standards* | *Percent* | *G.C.C.S. standards* | *Percent* | *WHO Standards* | *Percent* |
|---|---|---|---|---|---|---|---|
| ***TH** | *55-2793* | *500* | *30%* | *500* | *30%* | **NS* | *00%* |
| ***Cl⁻** | *18-1759* | *600* | *30%* | *400* | *30%* | *250* | *30%* |
| ***$NO^-_3$** | *0-60* | *<45* | *20%* | *<45* | *20%* | *50* | *20%* |
| ***$SO^{-2}_4$** | *400* | *400* | *10%* | *250* | *10%* | *250* | *10%* |
| ***TH: Total hardness, *CL-: Chloride, *$NO^{3-}$: Nitrates, *$SO^{-2}_4$: Sulfate** | | | | | | | |

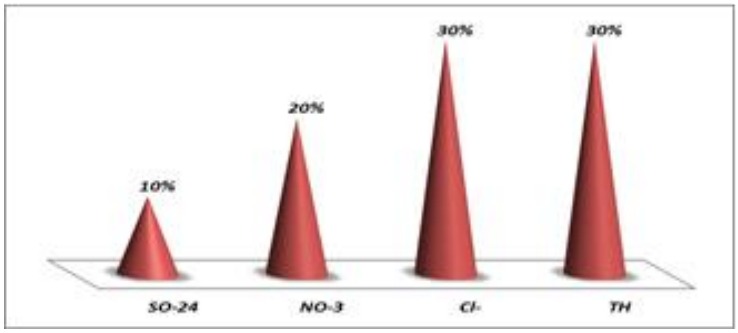


***Fig.5: Prevalence of chemical quality***

Table 2 and figure 5 showed prevalence of chemical quality, according to the standards and guideline limits for drinking water, such high salinity water was considered unsuitable for drinking in GW samples (3, 4 and 10) but could be used for irrigating crops with good salt tolerance such as date palm trees[5, 8-10]. TH was high in GW samples (3, 4 and 10), the observed result of EC and TDS, overall, these results showed a direct relationship between (TH, EC and TDS)[1-3].

TH main consist are ($CaCO_3$, $Cl^-$, $SO_4^{2-}$ and $NO_3^-$), $CaCO_3$ ranged (55-2793) mg $L^{-1}$ with 30% of GW samples being above 500 mg $L^{-1}$, GW samples (3, 4 and 10 ) irrigation. GW standard limit set by (SASO and G.C.C.S.)[8-10], TH of more than (300–500) mg $L^{-1}$ was considered excessive for a public water supply and results in high soap consumption as well as objectionable scale in heating vessels and pipes[8-10]. $Cl^-$ ranged (18-1759) mg $L^{-1}$ with 30% of GW samples were above SASO standard limits[8-10] and 70% of GW samples within (G.C.C.S and WHO) standard and guideline limits[1-3, 8-10]. $SO_4^{2-}$ ranged (33-2245) mg $L^{-1}$ with 90% of GW samples falling above each of (SASO and G.C.C.S)[8-10] standard limits and 10% above WHO standards[8-10]. $NO_3^-$ ranged (0–60) mg L−1 with

80% of GW samples thus falling below the limit of 50 mg $L^{-1}$ and 20% below this limit, which WHO standards[1-3, 8-10].

***Table 3: Prevalence of bacterial quality by bacterial growth***

| *Item* | *Bacterial growth* | | | |
|---|---|---|---|---|
| *Samples K *No.* | *Growth rate* | *Bacterial type *No.* | *Gram stain* | |
| | | | *Positive* | *Negative* |
| ***K1*** | + | *2* | + | - |
| ***K2*** | - | *0* | - | - |
| ***K3*** | + | *1* | + | - |
| ***K4*** | + | *2* | + | + |
| ***K5*** | + | *2* | + | + |
| ***K6*** | + | *2* | + | - |
| ***K7*** | + | *2* | + | - |
| ***K8*** | + | *2* | + | + |
| ***K9*** | + | *2* | + | + |
| ***K10*** | + | *2* | + | + |
| ****GW: Groundwater, *No: Number*** | | | | |

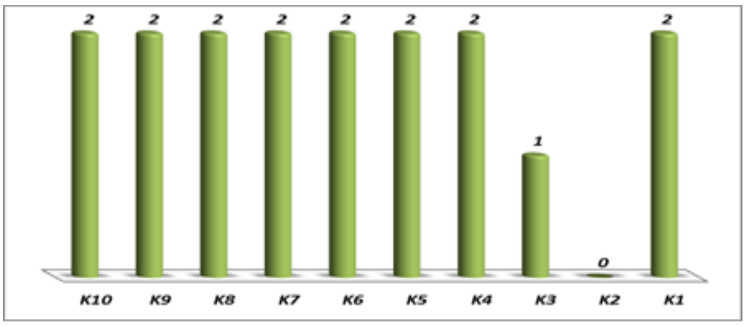


***Fig.6: Prevalence of bacterial quality by bacterial growth***

Table 3 and figure 6 showed prevalence of bacterial quality by bacterial growth, the result of the bacterial growth were present in all GW samples except sample 2. The types of bacteria present as one type in sample 3, in the rest found two types. Gram positive bacteria found in all except sample 3, either joined Gram negative samples except for samples (1, 2, 3, 6 and 7). That meaning the presence of both Gram positive and negative in the same GW samples at the same time as in (4, 5, 8, 9 and 10)[1-2, 4-5].

This results indicated the bacterial contamination of GW samples, often from the (faecal sewage, farms sewage and irrigation water), as well as the deposition of soil and rock[1-2, 4-5]. The GW must be tested and then treated because it might cause bacterial poisoning, food poisoning, which could lead to the impact on (human health, animal, birds and plant)[8-10].

***Table 4 : Prevalence of bacterial quality by bacterial *CFU/mL***

| *Item* | *Bacterial growth* | | | |
|---|---|---|---|---|
| *Samples K *No.* | *Colony count* | | **CFU/mL* | |
| | *Gram stain* | | | |
| | *Positive* | *Negative* | *Positive* | *Negative* |
| ***K1*** | *280* | *00* | *28000* | *00* |
| ***K2*** | *00* | *00* | *00* | *00* |
| ***K3*** | *15* | *00* | *1500* | *00* |
| ***K4*** | *20* | *5* | *2000* | *500* |
| ***K5*** | *13* | *10* | *1300* | *1000* |
| ***K6*** | *30* | *00* | *3000* | *00* |
| ***K7*** | *29* | *00* | *2900* | *00* |
| ***K8*** | *50* | *1* | *5000* | *100* |
| ***K9*** | *250* | *300* | *25000* | *30000* |
| ***K10*** | *20* | *6* | *2000* | *600* |
| ****No: Number, *CFU/mL: Colony Forming Unite/mL*** | | | | |

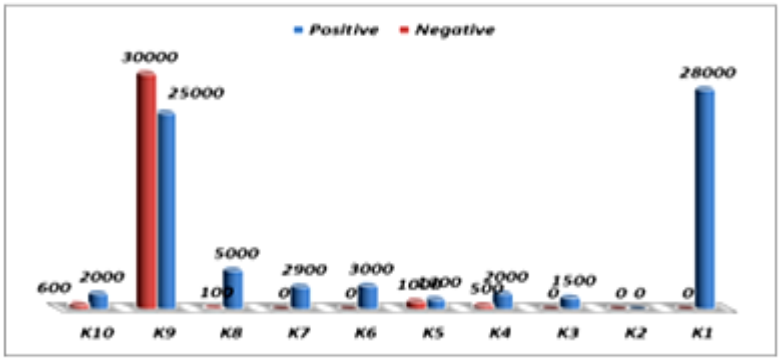


***Fig.7: Prevalence of bacterial quality by bacterial *CFU/mL***

Table 4 and figure 7 showed prevalence of bacterial quality by bacterial CFU/mL, from the colony count resulted in all GW samples were positive except sample 2 negative. The arrangement of colony count were in GW samples (9, 1, 8, 6, 7, 10, 4, 5 and 3) which contained total bacterial colony count (550, 280, 51, 30, 29, 26, 25, 23 and 15)/mL respectively, that was ranged colony (550-15)/mL[1-2, 4-5].
This colony count were in CFU/mL as descending manner in (Gram positive + Gram negative); ([25000+30000], [28000], [5000+100], [3000], [2900], [2000+600], [2000+500], [1300+1000], [1500])/mL respectively, that was ranged ($5.5X10^4$-$1.5X10^3$) CFU/mL[1-2, 4-5].
The common bacteria were isolated of Gram positive were (*Staph. spp* and *Micrococcus spp*) and Gram negative were (*E. coli* and *Klebsiella spp*)[1-2, 4-5].
The result rates of bacteria were higher than the authorized world average "Gold Standard" which allowed to community use, so that, the use of this GW may lead to community dangers for all living creatures as (humans, animals, birds and plants)[8-10].
From the all results of practical part, that found there may be a differences in the water quality of GW in HA area than NA area that must be considered in SS[8-10].

## 4. CONCLUSIONS

According to the results of present investigation, the conclusions drawn according to analyses of 10 GW samples used for purposes, "Regular assessment of GW to assist health and economic development in SS "VISION 2030 G", Taif, KSA", this water was including (drinking, domestic, cooking and irrigation). The purposes revealed there were considerable variations among the examined GW samples with respect to their constituents which mostly fell above the maximum permissible levels set by (SASO, G.C.C.S., WHO, EEC and USEPA) standards and guidelines. As well as for bacterial quality revealed the presence of bacterial faecal contamination which can cause infection and food poisoning or toxic production that will affect SS. The recommendation to "MOH and MOIAL", they must follow up the regular quality of GW at HA area which using for "human, animal, birds and plant resources" to protect the CH and helping SS.

## 5. ACKNOWLEDGEMENTS

All thanks were sent to (Civil Eng. Adel Kelaiker Kody, Miss. Jawaher H. Al-Zaidi, Sciences College, Taif University, KSA and all persons), that who helped in this paper work.

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**Online publication Date: 26.02.2018**