EVALUATION OF SOME MICROBIOLOGICAL AND CHEMICAL CHARACTERISTICS FOR SOME WATER WELLS IN SEBHA

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ABSTRACT

The present study aimed to evaluate some of microbial and chemical qualities of water samples collected from three wells in Sebha-Libya. The microbiological and chemical analysis were carried out on water samples collected from three wells located at different Sebha regions namely; El Thanawia well (ThW), Alminshia well (MW) and Al korda well (KW). The microbiological analyses included heterotrophic plate count (HPC), total coliform (TC), fecal coliform (FC), *Escherichia coli* (EC) and fecal *Streptococci* (FS). Chemical analyses included hydrogen ion concentration (pH), electrical conductivity (EC), total dissolved solids (TDS) and total alkalinity. Results of this study indicated that water of the three studied wells is not acceptable for human drinking since the number of FS exceeds the permissible limit recommended by WHO, however pH, EC, TDS and total alkalinity of all collected samples were acceptable. Water of the three studied wells should be treated against microbes contamination for human use with no risk. It worthy to mention that water of the studied could be safety used in irrigation of all crops.

Key words: Water quality, microbiological analysis and chemical analysis.

INTRODUCTION

Water resources are scarce in arid and semi arid regions because of low rainfall and extreme climatic conditions, which enhance water losses by evaporation (Shaki and Adeloye, 2006). The situation in Libya is typical, with average yearly rainfall of less than 100mm and average annual evapotranspiration of 6.8 mm/day (IMB, 1980). Sebha is located in Southern Libya. Problems in Sebha include desertification and very limited natural fresh water resources. Thus, one of the main restrictions facing agricultural development in Libya is the shortage of water resources. Therefore, Libyan government decided the exploitation of ground water available in the Southern Libyan desert to domestic drinking water and agriculture. Pedly and Howard, 1997 reported that microbial contamination of ground water has been responsible for many disease outbreaks. The microbiological quality of water is usually determined by looking for the presence of fecal coliform and fecal Streptococci. Their presence, therefore, indicates definite fecal contamination (Greenberg *et al*., 1992 and Powell *et al*., 2003). Other microbial parameters included in microbial quality of water such as, total heterotrophic plate count bacteria were reported by Lye and Dufour (1991); Payment *et al*., (1994) and

Elberg *et al*. (1997). Both human activities and natural resources have been found to contaminate ground water (Hallberg, 1989 and Gosselin *et al*., 1997). In addition, there are many other potential chemical pollution sources such as mining, high application rates of fertilizers, industrial wastes and lowered water tables (Weigman and Kroechler, 1990).

The present study aims to evaluate some of the microbial and chemical qualities of water samples collected from three wells in Sebha-Libya.

MATERIALS AND METHODS

1-Study area and weather station:

Sebha city located in southwestern Libya, about 750 km from Tripoli. Sebha co-ordinates are latitude: 27^{o} 01' N, longitude: 14^{o} 26' E and 432 m above sea level (Fig. 1). The climate of Sebha is characterized by high temperature in summer months (average maximum of 42.2 ^{o}C in June) with a minimum of about 3.2 ^{o}C in January. The annual mean relative humidity ranges from 47.82 % in January to 23.25 % in June. The highest mean wind speed is 6.14 m/sec in April, while the lowest value is 4.10 m/sec in January.

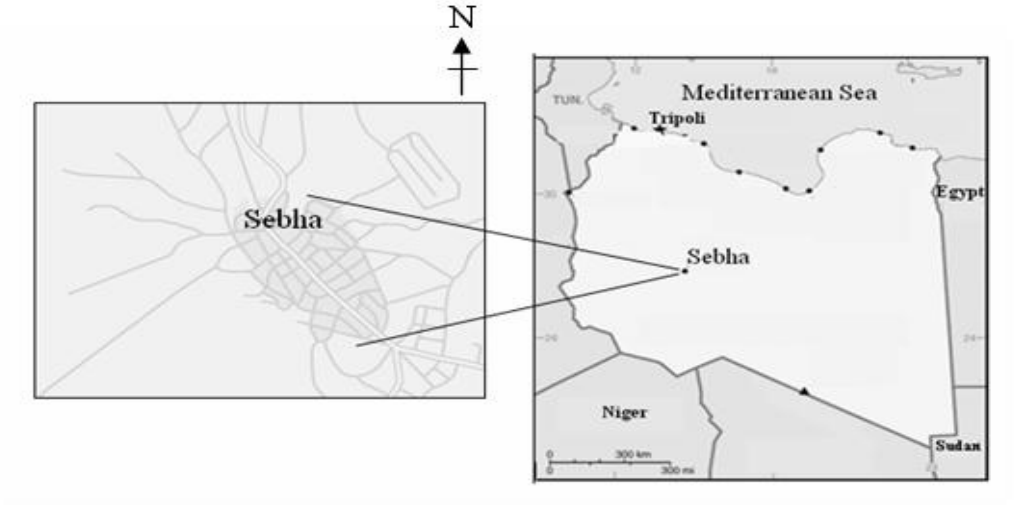

Fig. (1): Study area (Sebha city)

2-Water samples:

The studied wells were:

- El Thanawia well (ThW)
- Alminshia well (MW)
- Al korda well (KW)

Water samples were collected from the aforementioned selected sites in sterilized sample bottles and kept refrigerated in coolers with ice packs. Taps of pumps, in the different sites allowed running for 5 minutes before actual sampling. The aseptic techniques followed during water sampling and transportation.

3- Microbiological determinations:

Water samples were directly subjected to microbiological Lab. to carry out the microbiological analysis, using methods and media as described by **APHA (1998)** and **Csuros and Csuros (1999)** except otherwise stated.

a) Heterotrophic plate count (HPC):

Heterotrophic plate count formerly known as the standard plate count was determined in water samples using tryptone-glucose-yeast agar medium. Pour plate method was adopted and incubation was allowed at 35°C for 48 h. Counts of colonies were expressed as colony forming unit (cfu)/ml of sample.

b) Total coliform (TC):

The membrane filters (MF) technique was used with M-Endo agar medium for the determination of total coliform. The plates were incubated at 35°C for 24 h. Pink to dark-red color with metallic surface sheen colonies were counted. Total coliform count expressed as cfu/100 ml of water sample.

c) Fecal coliform (FC):

The membrane filter technique used by allowing an appropriate water sample (100 ml) to pass through a membrane filter that retains the bacteria present in the sample. The filter containing the bacteria was placed on M-FC agar in a Petri dish. After being incubated at 44.5°C for 24 h the typical blue colonies were counted and reported as fecal coliform count per 100 ml sample.

d) Escherichia coli (EC):

Enumeration of *E. coli* carried out according to Speck (1984). Tubes of EC broth inoculated by water samples and incubated at 45.5°C for 48 h. The tubes showed gas were subcultured on EMB agar for 24 h at 35°C and examined for typical dark-centered sheen colonies. On the base of number of positive tubes in each dilution, MPN of *E. coli* computed per 100 ml sample using MPN tables.

e) Fecal Streptococci (FS):

A suitable volume of a sample was passed through 0.45 μm membrane filter which retains the bacteria. The filter was placed on KF *Streptococci* agar medium and incubated at 35°C for 48 h. Red and pink colonies were counted as *Streptococci* and expressed as cfu/100 ml.

4- Chemical determinations:

To evaluate ground water quality and suitability for drinking the following procedures were used:

a)Hydrogen ion concentration (pH) :

Hydrogen ion concentration was measured as pH value in the collected water samples using a combined electrode connected to a laboratory pH meter with a glass electrode.

b)Electrical conductivity (EC) :

Electrical conductivity was determined in water samples using electrical conductivity bridge according to the method described by Jackson (1958).

The electrical conductivity expressed in micro-Siemen units per centimeter (MS/cm).

c) Total dissolved solids (TDS) :

Total dissolved solids were determined in water samples according to Csuros (1997), and expressed as mg/ml.

d) Total alkalinity:

Total alkalinity of water was measured by the method recommended by Csuros (1997) and expressed as mg/l.

RESULTS AND DISCUSSION

1- Microbiological analyses:

The microbiological analyses were periodically determined in water samples obtained from the studied three wells in Sebha.

a) Heterotrophic plate count (HPC):

Results presented in Table (1) and Fig (2) show the HPC tests for the three tested wells over two years. The data recorded for water samples taken from ThW were115 and 124 cfu/1 ml, 77 and 82 cfu/1 ml for MW, 65 and 76 cfu/1 ml for KW, respectively. The numbers of HPC in all tested samples (less than 500) are within the permissible levels according to WHO standards (1999).

Table(1): Heterotrophic plate count, Total coliform Group, Fecal coliform bacteria, Esherichia coli, Fecal *Streptococci* and Ratio between fecal coliform to fecal *Streptococci* counts.

Microbiological parameter (cfu/100ml)	El sanawia well (Th W)		Alminshia well (MW)		Al korda well (KW)		WHO
	1st	2ed	1st	2ed	1st	2ed	
HPC	115	124	77	82	65	76	500
TC	44	51	26	29	32	33	10
FC	8	10	5	6	2	4	5
E.coli	4	6	3	5	0	0	0
FS	13	18	6	9	7	9	0
FC/FS	0.62	0.56	0.83	0.67	0.29	0.44	

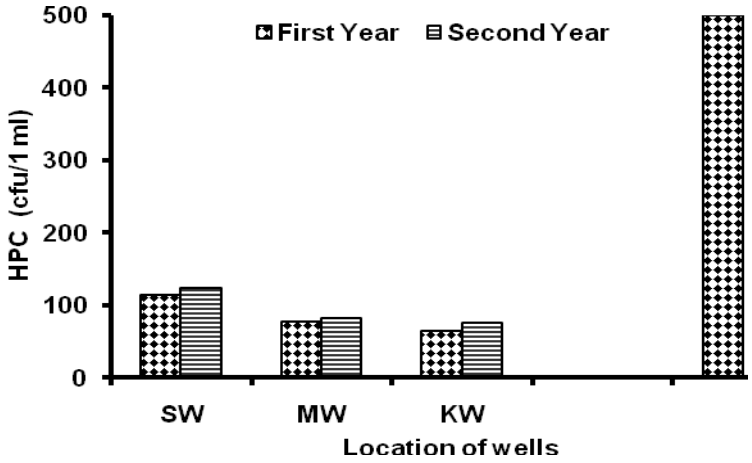

Fig (2): Heterotrophic plate count (HPC) in well water samples.

b) Total coliform Group (TC):

Data in Table (1) and Fig (3) show that total coliform bacterial counts (TC) of water samples for collected samples of the two years of study were 44 and 51 cfu/100 ml for ThW, 26 and 29 cfu/100 ml for MW and 32 and 33 cfu/100 ml for KW. It is obvious from the above data that (TC) counts were above the limit 10 cfu/100 ml, recommended for no risk (DWAF, 1996). However, it was mentioned that total coliform must be zero as recommended by other guidelines (USEPA, 2002).

In view of the high counts of total coliforms, and as suggested earlier by Mitchell (1978), samples could be classified as good fair (0-10 total coliforms per 100 ml), poor (11-50 total coliform as cfu/100 ml) and very poor (over 50 total coliforms per 100 ml).

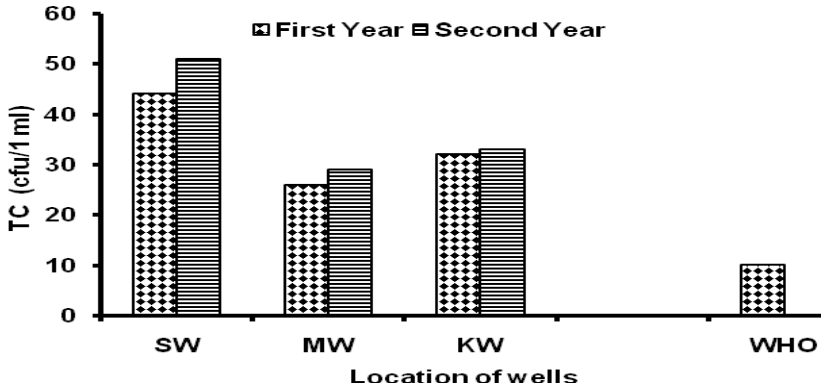

Fig (3): Total coliform Group (TC) in well water samples.

c) Fecal Coliform bacteria (FC):

The results obtained for ThW were 8 and 10 cfu/100 ml, 5 and 6 cfu/1 ml for MW and 2 and 4 cfu/100 ml for KW. Fecal coliform counts in the three wells, ThW, MW and KW ranged between 2 to 10 cfu/100 ml during two

years (Table 1 and Fig 4). The fecal coliform count in water wells had the order ThW >MW> KW. The value above 10 cfu/100 ml is considered toxic (USEPA, 2002). However, DWAF (1996) pointed that the maximum recommended limit for no risk is 5 cfu/100 ml.

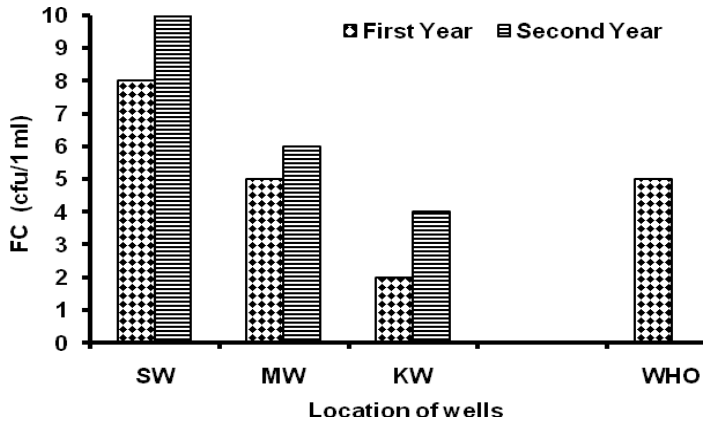

Fig (4): Fecal coliform bacteria (FC) in well water samples.

d) Esherichia coli (E. coli):

Results presented in Table (1) and Fig (5) show that the numbers of *E. coli.* in the three wells was 4 and 6 cfu/100 ml for ThW, 3 and 5 cfu/100 ml for MW and 0 cfu/100 ml for KW over the two years, respectively.

The values of the examined wells ranged from 0 to 6 cfu/100 ml. The highest numbers of *E. coli* observed in ThW and MW. This observation may be due to the uncontrolled domestic activities in those sites rather than KW. The maximum contamination level (MCL) of *E. coli* is zero cfu/100 ml in drinking water (USEPA 2002).

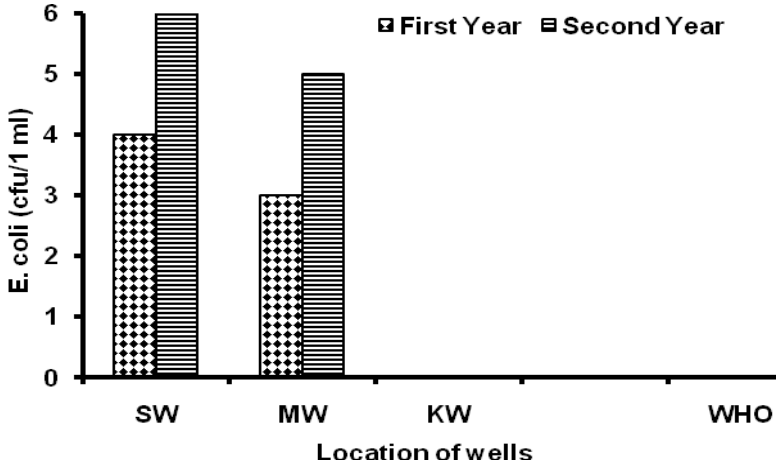

Fig (5): *Esherichia coli* (E. coli) in water well samples

e) Fecal *Streptococci* (FS):

Results of fecal *Streptococci* (FS) for the three wells are shown in Table (1) and Fig (6). The results obtained for ThW were 13 and 18 cfu/100, 6 and 9 cfu/100 ml for MW and 7 and 9 cfu/100 ml for KW for the 2 years, respectively. FS counts ranged between 6 to 18 cfu/100 ml for the three wells over the two years. It could be noted that the occurrence of fecal *Streptococci* in water samples indicates fecal contamination by warm-blooded animals wastes. Furthermore, the presence of fecal *Streptococci* in water samples indicates recent contamination.

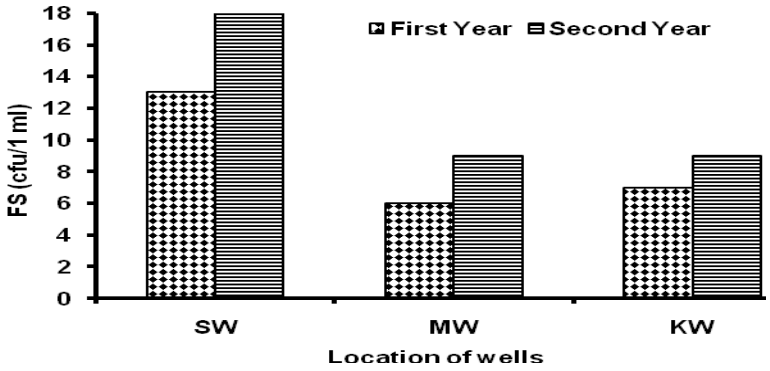

Fig (6): Fecal *Streptococci* (FS) in well water samples.

f) Ratio between fecal coliform to fecal *Streptococci* counts:

Results in Table (1) and Fig (7) show the ratio between the fecal coliform (FC) and fecal *Streptococci* (FS) densities. This formula (FC/FS) indicates the probable source of water pollution. The results obtained for ThW were 0.62 and 0.56 cfu/100, 0.83 and 0.67 cfu/100 ml for MW and 0.29 and 0.44 cfu/100 ml for KW during the two years, respectively.

Mitchell, 1978 showed that FC/FS ratio of 4 or more means that the source of pollution is from human wastes, the ratio 1 or less means animal or chicken waste pollution and the ratio between 1-4 indicate that the source of pollution is a mixture of animal and human wastes. The results obtained from the three wells indicated that water contamination of examined samples may be due to animal dung sources rather than fecal human sources, since FC/FS ratio was found to be less than one in the samples.

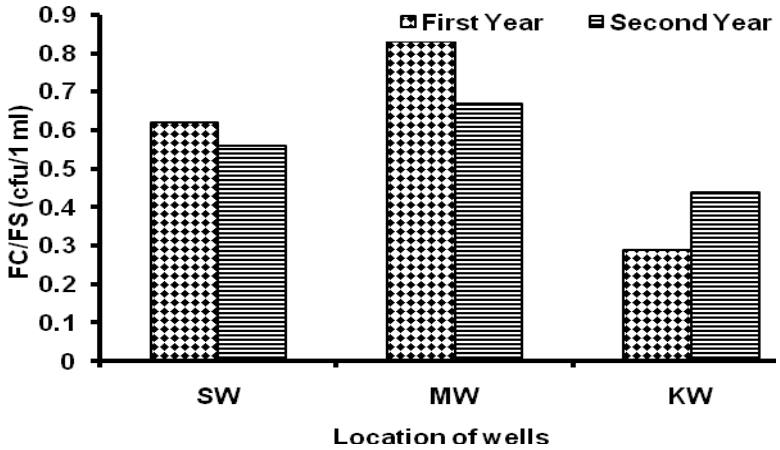

Fig (7): Ratio between fecal coliform to fecal *Streptococci* counts (FC/FS) in well water samples.

2- Chemical analyses:

a)pH values:

Results in Table (2) and Fig (8) show the pH values for the studied wells over two years. The maximum and minimum values of pH in all water samples ranged between 7.05 to 7.45 which are in agreement with those of drinking water directive standards of WHO, European Commission (EC) and Arabic Commission (AC) being 6.5-9.5, 6.0-9.0 and 5.5-9.5 respectively as reported by Gray (1999).

Table (2): pH values, Electrical conductivity (EC), Total dissolved solids (TDS) and Alkalinity in water samples.

Chemical parameter	El sanawia well		Alminshia well		Al korda well		WHO
	1st	2ed	1st	2ed	1st	2ed	
pH	7.40	7.15	7.05	7.13	7.32	7.45	6.5-9.5
EC	314	512	275	490	150	365	1500-2000
T.D.S mg/l	159	357	125	261	90	183	1000
Alkalinity	46	79	33	63	30	63	200-250
T.H	44	179	62	183	39	104	250-300

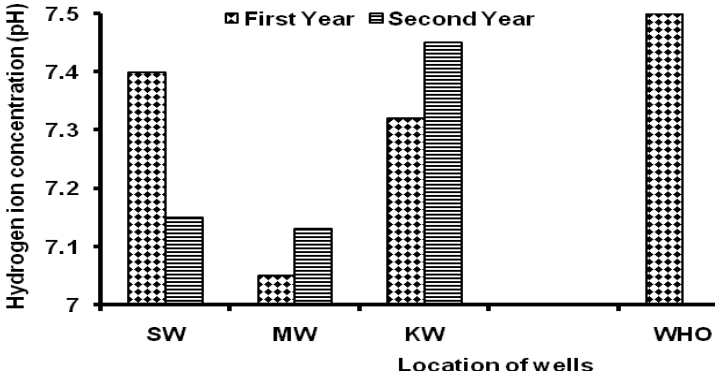

Fig (8): pH values of well water samples.

b)Electrical conductivity (EC) :

The results of EC are presented in Table (2) and Fig (9). Results of water EC showed that the EC values were 314 and 512 MS/cm, 275 and 490 MS/cm, 150 and 365 MS/cm over the two years for ThW, MW and KW, respectively. The values of EC in water samples ranged from 175-915 mS/cm, which are less than those of WHO, European Commission and Arabic Commission 1500-2000 mS/cm as reported by Gray (1999).

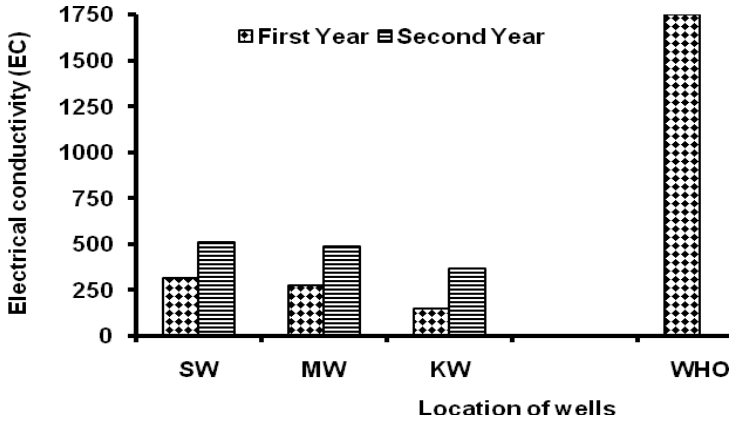

Fig (9): Electrical conductivity (EC) in well water samples.

c) Total dissolved solids (TDS):

Total dissolved solids (TDS) have an important effect on the taste of drinking water. The palatability of water with a TDS level of less than 600 mg/liter generally considered good. Drinking water becomes increasingly unpalatable at TDS levels greater than 1200 mg/liter (WHO, 1999). Results in Table (2) show that all water samples had acceptable values of TDS over the two years. The values of TDS of all tested samples ranged between 125-457 mg/l. It could be noticed that these values are compatible with those of EC values recorded in (Table 2 and Fig 10) and acceptable to WHO, European Commission and Arabic Commission limits.

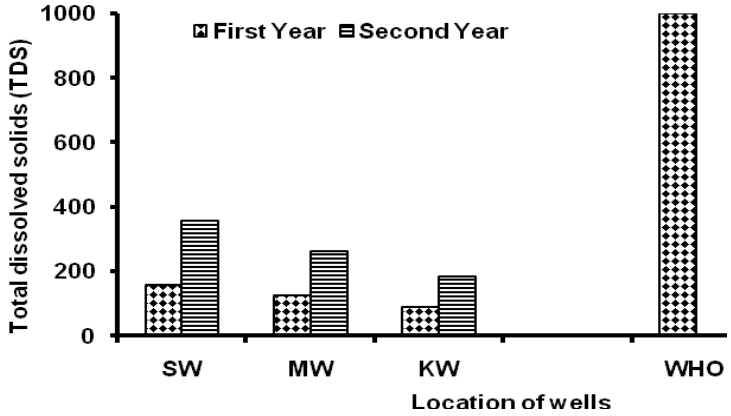

Fig (10): Total dissolved solids (TDS) in well water samples.

d) Alkalinity:

Results in Table (2) and Fig (11) show that water alkalinity values were 46 and 79 mg/l for ThW, and 33 and 63 mg/l for MW, and 30 and 63 mg/l for KW over the two years, respectively. Obtained results are within the range previously suggested by WHO, European Commission (EC) and Arabic Commission (AC) who recommended 200-250 mg/l as acceptable total alkalinity in drinking water as reported by Gray (1999).

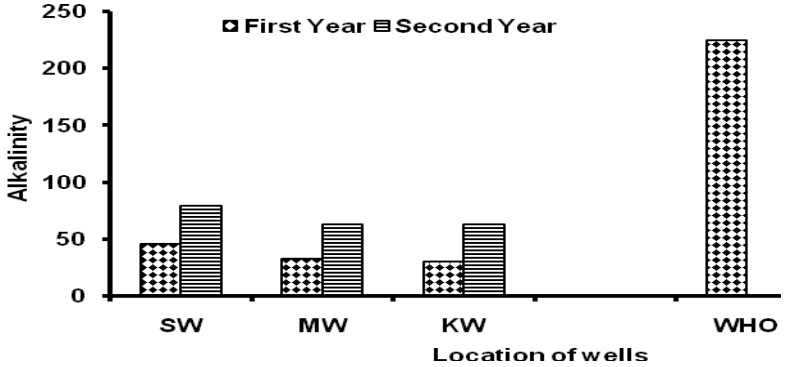

Fig (11): Alkalinity in well water samples.

According to WHO, European Commission (EC) and Arabic Commission (AC) for drinking and based on results obtained during the present study the following could be concluded:

a)Water of all the three studied wells contained acceptable values of EC, pH, TSD and total alkalinity.

b)Water of all the three studied wells are not microbiologically acceptable for drinking since microbiological showed that water samples of all the wells are contaminated with greater counts of fecal coliform (FC) that recommended by WHO, European Commission (EC) and Arabic Commission (AC).

c)Water of all the three studied wells should be treated against microbes contamination for human use.

d)According to Ayers and Westcot (1985) guidelines, water of the studied could be safety used in irrigation of all crops.

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تقييم بعض الصفات الميكروبيولوجية والكيميائية لمياه بعض الآبار في سبها

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تهدف الدراسة إلى تقييم بعض الصفات الميكروبيولوجية والكيميائية لبعض مياه الابار في سبها-ليبيا. أجريت التحليلات على عينات المياه جمعت من ثلاثة آبار بمنطقة سبها هي بئر الثانوية والمنشية والقرضة.

وقد اشتملت التحليلات الميكروبيولوجية تقدير العدد الكلى للبكتريا والعدد الكلى لبكتريا القولون وعد بكتريا القولون البرازية وعدد بكتريا *E. coli* وعدد بكتريا *Streptococci* البرازية ، واشتملت التحليلات الكيميائية علي تقدير الأس الايدروجينى والتوصيل الكهربائى والأملاح الكلية الذائبة والقلوية الكلية وعنصر الحديد .

أوضحت الدراسة أن كل التحليلات الكيميائية المختبرة تقريباً مقبولة ومطابقة للمواصفات القياسية لمياه الشرب طبقاً لمنظمة الصحة العالمية، أما بخصوص التحليلات الميكروبيولوجية فقد أوضحت الدراسة التي أجريت علي العينات المختبرة أن مياه الآبار الثلاثة تحتوي على عدد كل من بكتيريا القولون الكليةtotal coliform ستربتوكوكاي البرازية *Streptococci* fecal أكبر من الحد المسموح به في مياه الشرب طبقاً لمواصفات منظمة الصحة العالمية.

وتوصي الدراسة بإجراء بعض عمليات المعالجة لمياه تلك الآبار لكي يمكن استعمالها في مياه الشرب. ويجب الاشارة الى ان مياه هذه الابار تصلح لري جميع المزروعات دون مشاكل.