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Investigation of Quality of Water in Shallow Wells in Some Rural Communities in Kwara State.

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Abstract

An investigation to determine the quality of water from shallow wells located in some selected rural areas of Kwara State was undertaken. The parameters studied include the physical, chemical and the bacteriological properties of well water. The laboratory analyses were carried out in accordance with standard methods of examination for water and wastewater; the results of the analyses were compared with World Health Organization (WHO) Standard for drinking water to ascertain the suitability of these sources of water. The results of the study revealed that pH and contents of iron, calcium, chloride, manganese and magnesium in the water were higher than the level of the recommended values in some wells. The bacteriological tests indicated that all the thirty wells had colony counts higher than the recommended value by the World Health Organization (WHO). It is recommended that the disinfectant is required to make the water portable for human use and consumption

Keywords:

Rural community, Groundwater, Quality characteristics, and Sources of water

1. Introduction

The definition of a rural community varies from country to country; generally the principal factors considered are the population and economic activities. In a study of problems of rural water supplies in Southeast Nigeria (Umar and Egboka, 1988) took a rural community as villages with population less than 5,000. The predominant economic activity in rural areas of Nigeria is agriculture and their major sources of water include rivers, shallow wells and lakes. In many villages of the rural community, accessibility to pipe-borne water is difficult or impossible. The absence of pipe-borne water made the inhabitant to depend solely on shallow wells and surface water. The quality of these sources varies and they may even be susceptible as they are not subject to any intense quality standards as pipe-borne water (Silberbauer, 1997). Alarms have been raised as a result of recorded episodes of disorders consequent upon the consumption of water from shallow wells. In order to improve access to safe drinking water, the United Nations designated the period 1981 – 1990 as the International Drinking Water and Sanitation Decade. The goal was to provide all people with water of safe quality and adequate quantity and basic sanitary facilities by 1990 (FMWR, 1998). Water fit for drinking exists in the ground at some depth nearly everywhere on earth; this does not mean that the available sources of water are safe.

Safe water is essential for good health and is a prerequisite to the control of diseases such as typhoid, cholera and dysentery, which commonly affect communities that do not have regular supply from treated sources. Groundwater source is the simplest and usually the most economical both to implement and to operate. The water is normally of good quality if not polluted, requiring minimum treatment (Arceivala and Bender1972, Tebbutt 1988, Uchegbu 1998). The World Bank in 1984 reported that water quality is declining steadily in many aquifers as a result of direct pollution or seepage from polluted water. Poor aquifer recharge is described as one of the problems facing groundwater sources. It has been tested and confirmed that in industrial areas infiltration of chemical precipitation and rock minerals into the geological beds contaminate the aquifers (KWSUB, 1987). The quality requirement of a groundwater supply depends upon its purposes, the needs for drinking water; industrial water and irrigation water vary widely. Some of the groundwater has been identified with objectionable physical, chemical and bacteriological characteristics. In this study, samples of water from selected shallow wells in some rural areas of Kwara State were examined to determine their quality characteristics and whether the water is fit for human consumption.

2. Methodology

2.1 Preliminary Survey

Prior to the collection of samples, preliminary survey was carried out to identify the location and selection of the suitable representative sources. A total of thirty wells are selected for the study. During the preliminary survey the general condition of the environment was studied, it was observed that the possible sources of pollution to the wells could be from the pit – latrines and the closet by refuse dumps. The location of the domestic refuse dump site and waste discharge from the houses are not adequately coordinated. In addition some of the villages have some traces of rock out crop which may have influence on the chemical characteristics of the groundwater sources in the study areas. Information was also collected through oral interview of people residing in these areas regarding the frequency of the outbreak of water borne diseases.

2.2 Collection and Laboratory Analysis of Water Samples

Water samples were collected inside clean bottles of 250ml. Each bottle was rinsed with the water being sampled before the sample was collected to ensure that the sample was not directly polluted. The bottle was securely corked to prevent contamination, labelled and promptly taken to the laboratory for quality analysis. The samples were analyzed for various physical, chemical and bacteriological characteristics in accordance to the standard of water and wastewater quality examination methods (AWWA 1976, APHA 1971, APHA 1972, KWSUB 2002). The physical parameters analyzed include temperature, colour, odour, and turbidity, while the chemical parameter analyzed include pH, Calcium, iron, manganese, magnesium and chloride. The bacteriological analysis involved the detection and determination of the biological life presents in the water especially the coliform bacteria (Escherichia Coli, E. coli). The total coliform counts of each sample were enumerated using the pour plate method. One milliliter of a 100 fold dilution was plated on Yeast Extract Agar and Eosing methylene blue agar (Olayemi 1994, Olayemi 1998, Sterritt 1988). The plates were incubated at 35° C and observed after 24 and 48 hours respectively. The multiple tube (MPN) method with elevated temperature of incubation was employed in enumerating the total faecal coliforms in the samples. The samples were collected and analyzed twice a month for a total period of three months. The mean values of the laboratory results are presented in Table 1 and Figures 1 – 12 and compared with (WHO, 1990) Standards for drinking water.

Table 1. Mean value of the laboratory results for water samples from wells

Quality parameters	Sources of water sample														
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Temperature °C	26.0	26.0	27.0	26.0	27.0	26.5	26.0	27.0	26.0	26.0	26.0	26.0	26.5	26.0	27.0
Colour (Hu)	5.5	5.0	6.0	6.0	6.0	6.0	5.5	5.5	6.0	6.5	6.0	6.0	7.0	7.0	7.0
Turbidity (NTU)	13.0	18.0	18.0	17.0	20.0	16.0	18.0	15.0	18.0	22.0	15.0	17.0	19.0	20.0	15.0
Total solids (mg/l)	150.0	155.0	152.0	160.0	158.0	153.0	159.0	152.0	184.0	160.0	250.0	270.0	190.0	270.0	260.0
Suspended solids (mg/l)	90.0	85.0	90.0	100.0	108.0	110.0	109.0	104.0	126.0	109.0	160.0	182.0	120.0	188.0	175.0
Dissolved solids (mg/l)	60.0	70.0	62.0	60.0	50.0	43.0	50.0	48.0	58.0	51.0	90.0	88.0	70.0	82.0	85.0
Total hardness	108.0	105.0	189.0	102.0	130.0	125.0	128.0	175.0	190.0	78.0	95.0	92.0	150.0	82.0	102.0
PH	7.0	7.2	7.9	6.3	6.7	6.9	6.0	6.3	6.5	8.0	6.5	6.0	6.5	6.8	6.3
Manganese (mg/l)	0.5	0.4	0.6	0.7	0.7	0.6	0.7	0.7	0.5	0.6	0.4	0.4	0.5	0.7	0.7
Calcium (mg/l)	22.0	21.0	19.5	18.5	20.0	21.0	19.5	20.5	21.5	19.5	20.0	20.5	19.0	19.5	19.0
Magnesium (mg/l)	6.0	5.0	5.0	6.0	5.0	4.5	4.5	5.0	4.5	4.5	5.0	4.0	4.5	5.0	4.5
Iron (mg/l)	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
Chloride (mg/l)	0.02	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01
Colony count (coliform/100ml)	12	15	13	16	16	12	12	14	17	13	11	13	15	17	14

Table 1. Continued

Quality parameters	Sources of water sample														
	W16	W17	W18	W19	W20	W21	W22	W23	W24	W25	W26	W27	W28	W29	W30
Temperature °C	26.0	27.0	25.0	26.0	26.0	26.0	26.0	27.0	26.5	27.0	27.0	26.0	26.0	25.5	27.0
Colour (Hu)	7.0	6.5	6.0	6.0	6.5	7.0	5.5	6.5	6.5	7.0	7.0	7.0	6.5	6.0	6.50
Turbidity (NTU)	13.0	20.0	15.0	15.0	18.0	15.0	18.0	19.0	17.0	22.0	18.0	16.0	18.0	15.0	19.0
Total solids (mg/l)	230.0	235.0	255.0	240.0	270.0	200.0	180.0	210.0	190.0	205.0	198.0	220.0	175.0	240.0	185.0
Suspended solids (mg/l)	170.0	165.0	185.0	168.0	195.0	145.0	128.0	149.0	118.0	135.0	130.0	180.0	150.0	189.0	120.0
Dissolved solids (mg/l)	60.0	70.0	70.0	72.0	75.0	55.0	52.0	61.0	72.0	70.0	68.0	40.0	25.0	51.0	65.0
Total hardness	100.0	98.0	130.0	140.0	75.0	115.0	110.0	175.0	100.0	148.0	200.0	180.0	195.0	149.0	95.0
pH	7.0	6.5	6.5	6.0	6.5	6.8	7.0	6.6	6.8	7.2	7.0	6.8	6.8	6.8	8.0
Manganese (mg/l)	0.6	0.6	0.7	0.4	0.5	0.5	0.4	0.5	0.7	0.7	0.7	0.6	0.7	0.5	0.6
Calcium (mg/l)	20.5	21.0	19.5	19.5	20.5	22.0	23.0	20.0	21.0	19.5	22.0	20.0	22.0	25.0	22.0
Magnesium (mg/l)	4.0	4.5	4.0	4.5	4.0	6.5	5.5	4.0	4.5	5.0	5.3	4.5	5.4	6.0	6.8
Iron (mg/l)	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.02
Chloride (mg/l)	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.01	0.01	0.00	0.01	0.01
Colony count (coliform/100ml)	14	16	16	14	16	14	12	16	17	11	16	12	16	15	17

Fig. 1 Comparison of temperature of water samples from the wells with WHO value

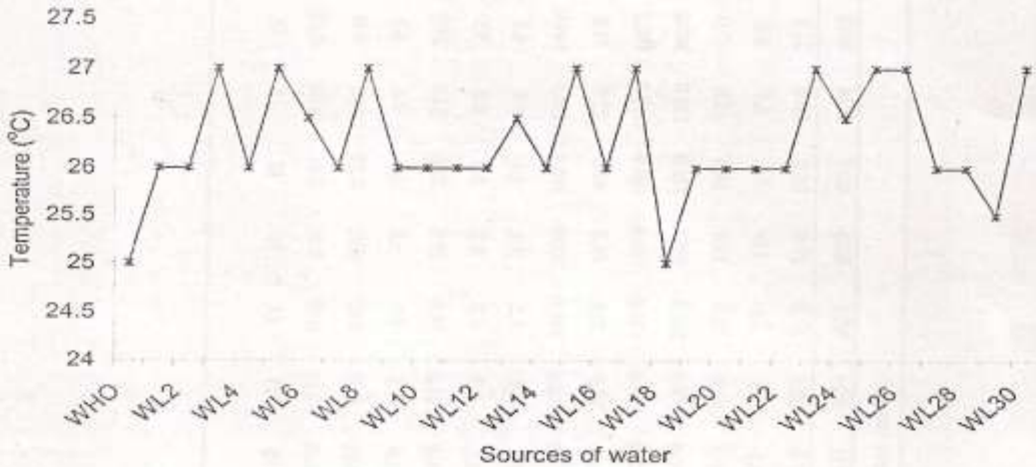


Fig. 2 Comparison of colour of water samples from wells with WHO value

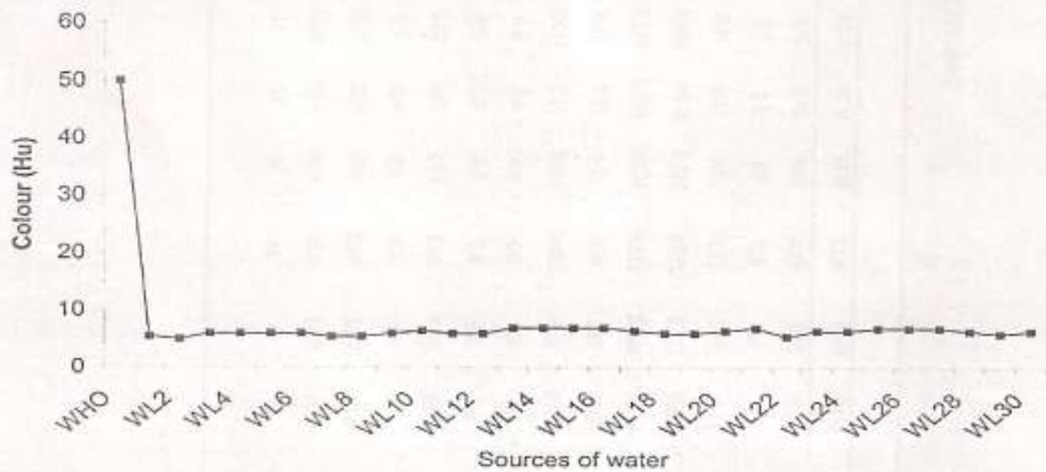


Fig. 3 Comparison of Turbidity of water samples from the wells with WHO value

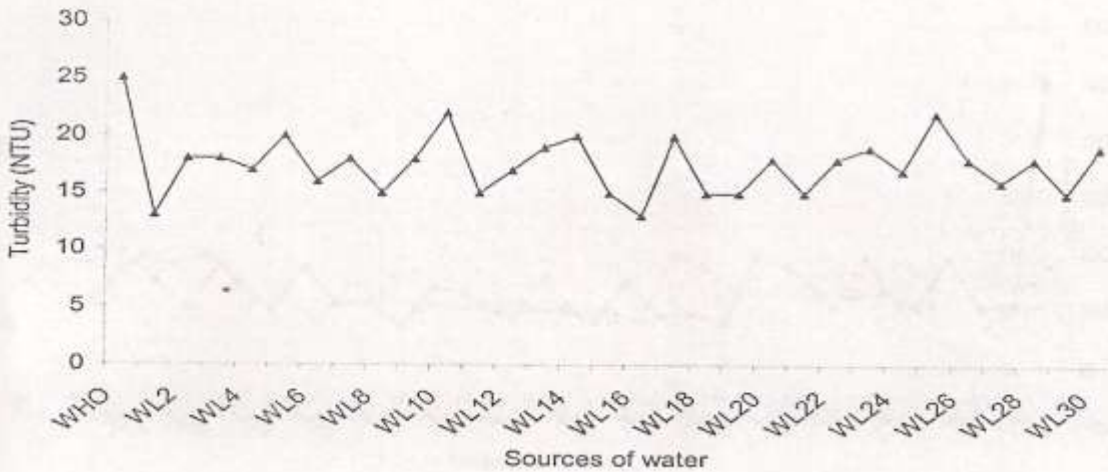


Fig. 4 Comparison of total solids in water samples from wells with WHO value

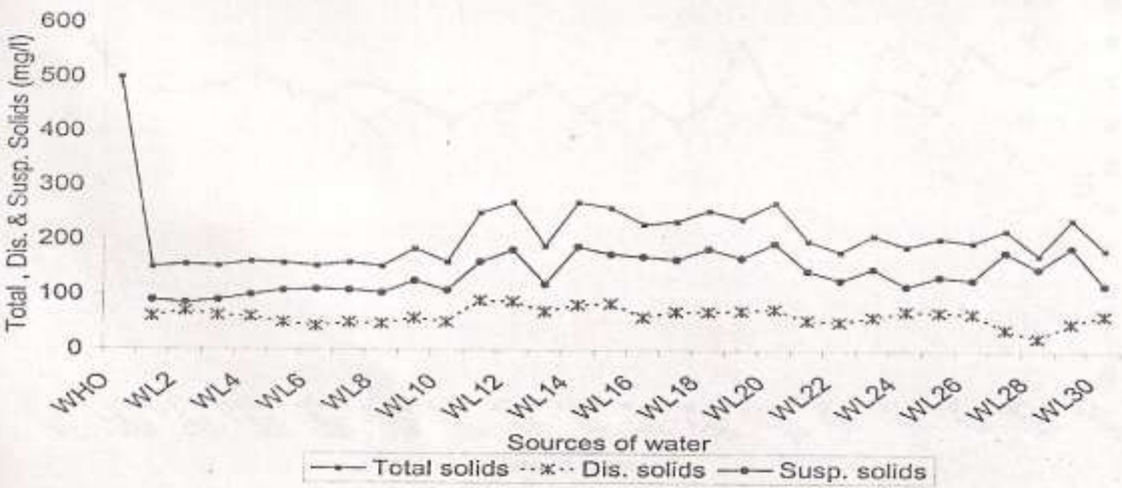


Fig. 5 Comparison of total hardness in water samples from wells with WHO value

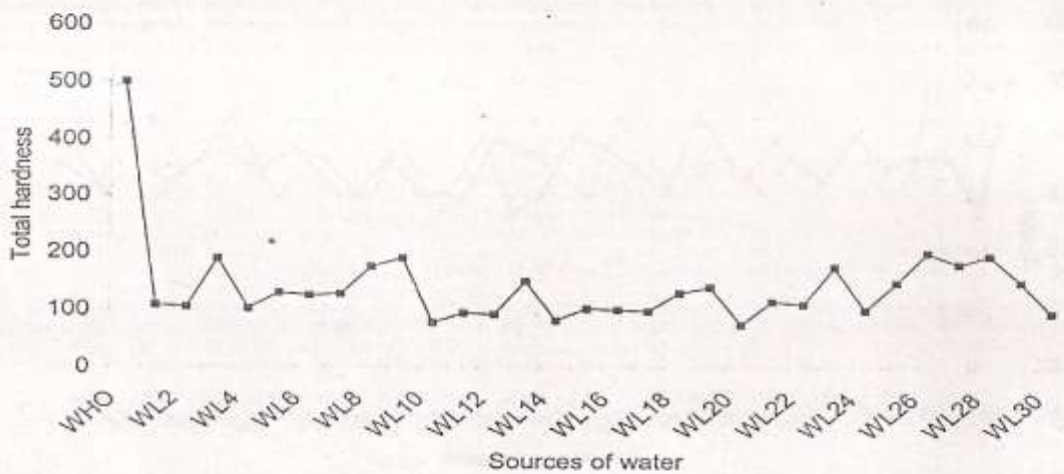


Fig. 6 Comparison of pH of water samples with WHO value

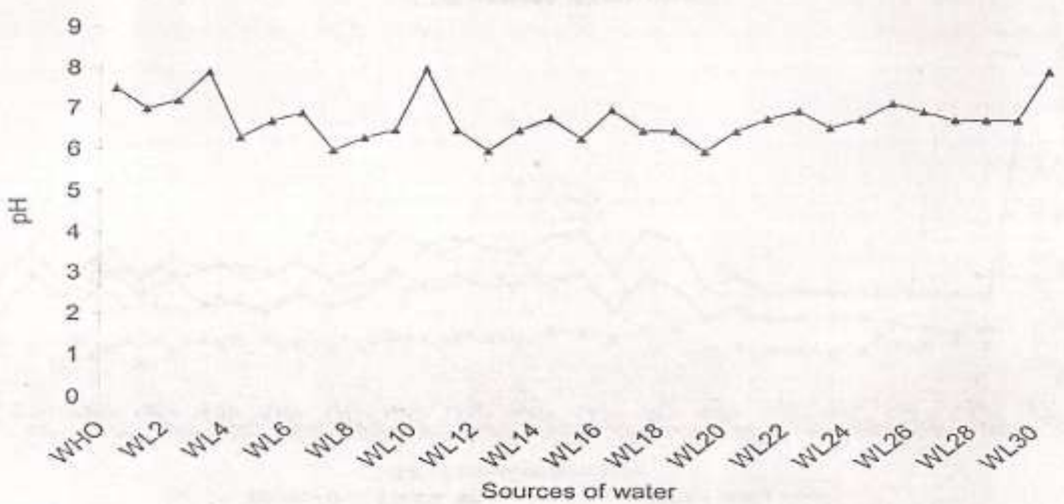


Fig. 7 Comparison of magnesium in water samples from the wells with WHO value

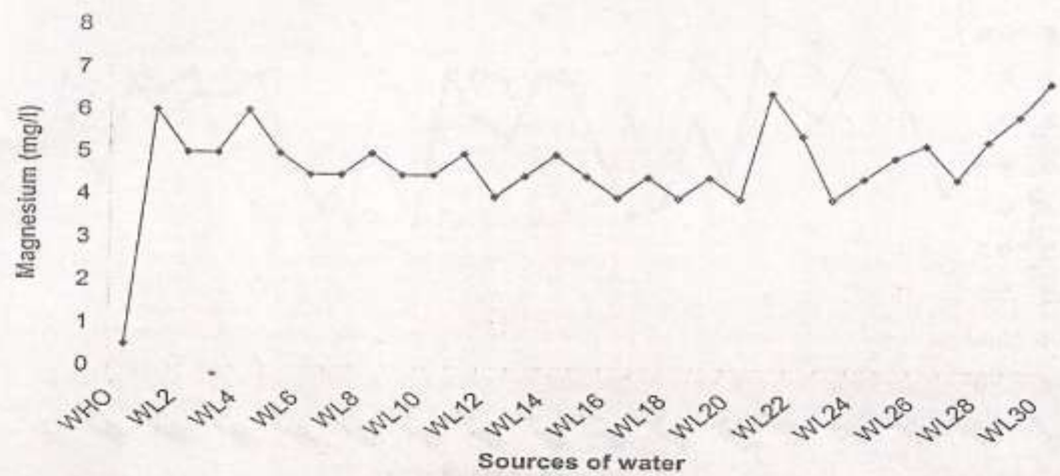


Fig. 8 Comparison of calcium in water samples from the wells with WHO value

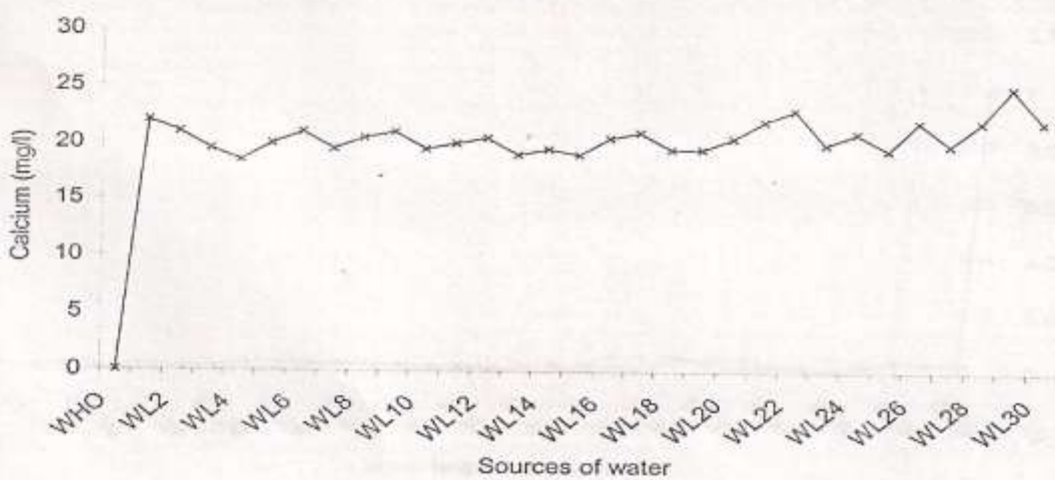


Fig. 9 Comparison of manganese in water samples from the wells with WHO value

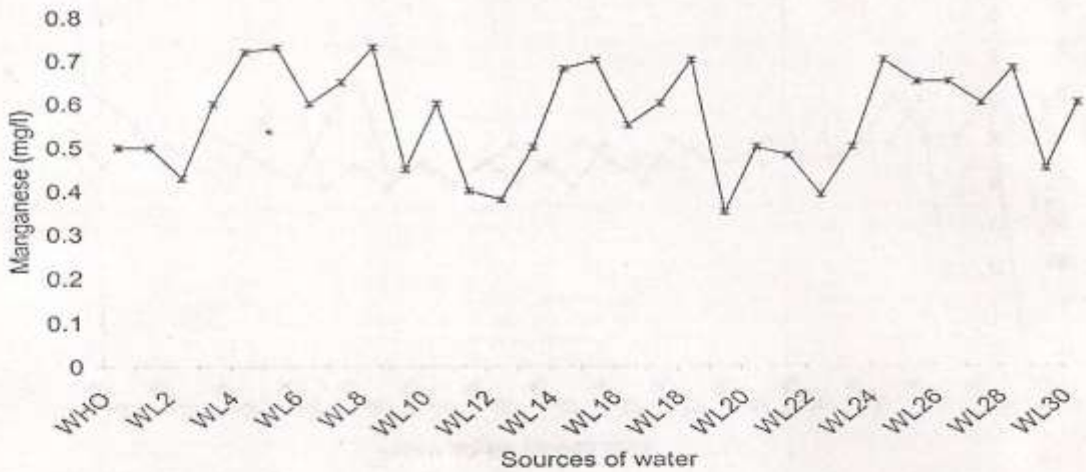
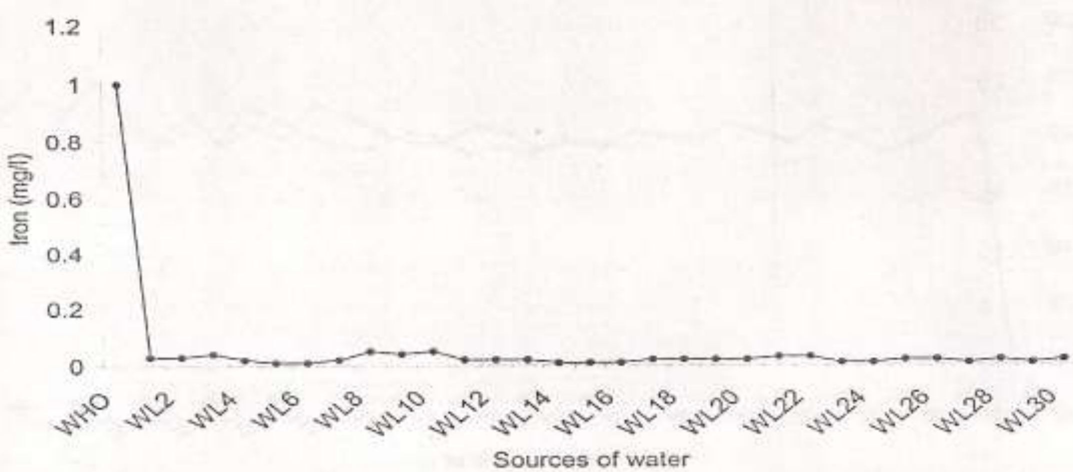


Fig. 10 Comparison of iron in water samples from the wells with WHO value



3. Discussion of Results

The laboratory analysis focused on the physical, chemical and bacteriological quality characteristics of water from the shallow wells.

3.1 Physical Characteristics

In a physical analysis of groundwater, temperature is reported in ^{o}C and measured immediately after the collection of the sample. Colour in groundwater may be due to mineral or organic matter in solution and reported in parts per million by comparison with standard solutions. Turbidity is a measure of the suspended and colloidal matter in water, such as clay, silt, organic matter and microscopic organisms. Tastes and odour may be derived from bacteria, dissolved gases, mineral material or phenol. Salami, [10]) stated in the study of quality characteristics of groundwater sources in some selected rural communities that the mean value of water temperature ranges from 25 – 27 ° C and the variation is shown in Figure 1. The colour of water in the selected wells is within the World Health Organization (WHO) standards for drinking water recommended value of 5-50 Hu. The smallest value of colour was 5 Hu for well w2; while the maximum value was 7 Hu for wells w13, w14, w15, w16, w21, w25, w26 and w27, the variation is shown in Figure 2. The mean value of turbidity is within the recommended value of 5 – 25 NTU, this could be due to the lower value of the dissolved solid compared with the suspended solid. The least value was 13 NTU for wells w1 and w 16; while the maximum value was 22 NTU for wells w10 and w5, the variation is shown in Figure 3. The mean value of total solid is below the recommended value of 500 – 1500 mg/l, the least value was 152 for wells w3 and w8; while the maximum value was 270 for wells w12 and w20. This is attributed to the fact that almost all the tested wells have top covers and always remains locked except when water was being fetched; the variations in total, suspended and dissolved solids are shown in Figure 4. The mean value of total hardness is also within the recommended value of 100 – 500 mg/l, the least value of total hardness was 75 for well w20; while the maximum value was 195 for well w28; the variation is shown in Figure 5.

3.2 Chemical Characteristics

Chemical analysis includes the determination of the concentration of all the inorganic constituents present in water, pH, calcium, iron, manganese, chloride and other chemical constituent in water. The test results shows that the pH values of water in all the selected wells are within the recommended value of 6.5 – 8.5, the least value of pH recorded was 6.0 for wells w7, w12 and w19; while the maximum value was 8.0 for the wells w10 and w30. Though low pH of water results in corrosion of metallic buckets and household utensils, a pH of 6.0 is not too acidic to cause serious corrosion problems; the variation of pH is shown in Figure 6. The mean value of magnesium in the wells varies from 4 – 6 mg/l, which is above the maximum permissible level of 0.5 mg/l; the variation is shown in Figure 7. Also, the mean value of calcium varies from 19 – 22 mg/l and the range is above the allowable level of 0.01 mg/l; the variation is shown in Figure 8. The mean value of manganese in wells w3 – w8, w10, w14 – w18, w24 – w28 and w30 are higher than the maximum permissible level of 0.5 mg/l; the variation is shown in Figure 9. The higher level of calcium, magnesium and manganese present in some of the wells would result to hardness and the water will not easily make leather with soap. The value of iron in each of the thirty wells is below the maximum permissible value of 0.05 mg/l; while that of chloride in each of the thirty wells is between 0.0 – 0.02 mg/l with the highest value below the recommended maximum permissible value of 0.05 mg/l, the variation of iron and chloride are shown in Figure 10 and 11 respectively. The low value of iron and chloride in the wells result to none objectionable taste and low turbidity, thus prevent formation of deposit in the water containers and growth of bacteria.

3.3 Bacteriological Characteristics

The third important characteristic of water used to determine its suitability for human consumption is the bacteriological analysis. This is very useful for detection of sewage contaminant in groundwater because bacteria of the coliform group are relatively easy to isolate and identified. The result of the bacteriological test revealed that the water in each of the thirty wells have traces of fecal coliform and the colony counts are higher than the maximum allowable value of 10 per 100 ml recommended by World Health Organization standards for drinking water. This is an indication that the water is not save for human consumption, the variation is shown in Figure 12.

The public health implications of the results of this study and other observations make it important for the authorities of Kwara State Environmental Protection Agency (KWEPA) and Ministry of health to visit and carryout quality control tests for the water in the shallow wells of the rural communities in Kwara State. Water disinfection in the well can be accomplished by diffusion of Chlorine through jar (Tebbutt, 1988). The chlorine jar is made of clay pot (12 to 15 litres in volume) filled nearly half – way with a mix of 1.5 Kg bleach powder and 3 Kg coarse sand (grain size 1.4 to 1.6 mm). It has two holes above the sand surface, covered with a plastic foil and suspended approximately 1 m below the water surface in the well. The chlorine thus diffuses through the two holes into the well water. This is applicable in wells of 9 to 13 m^3 volume of water, with daily removal of 10% water (0.9 to 1.3 m^3). The effectiveness is one week at residual chlorine content of between 0.2 and 0.8 mg/l.

4. Conclusions

Public health and socio-economic development of an area can be enhanced if there is adequate, accessible and safe water supply. The availability of potable water plays a key role in the realization of health improvement measures in any community. It is an acceptable fact that potable water supply contributes to reduce the infancy mortality and mobility rate and increase the children's life expectancy if there is reduction in the incidences of water-related diseases. This study however, revealed the quality characteristics of water from shallow wells in the selected communities and the result enables the establishment of the suitability of this source of water for domestic purposes. It could be deduced that almost all the quality characteristics are within the WHO Standards recommended except that the percentage quantities of calcium, manganese, magnesium and iron are higher in some wells. In addition the colony count is higher than the WHO permissible value of 10/100 ml in all the wells. Thus, the water from all the wells is not adequately suitable for drinking except when disinfected.

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