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Research Paper

Assessment of Ikogosi Warm Spring Water Quality in Ekiti State, South Western Nigeria.

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ABSTRACT

A 6-month study spanning the wet and dry seasons was conducted on Ikogosi warm spring in South Western Nigeria to assess the variation in the quality of the warm spring water and a well in the middle of the town. Laboratory analyses were carried out to determine the physical, chemical and bacteriological characteristics of the water. The results of physical and chemical analyses of the water samples for the two seasons of the year fell within WHO and SON water quality standard. The results of the bacteriological analysis showed that water at the source is very pure and free from bacteriological organisms. However, as it moves down the warm spring, the bacteriological quality deteriorates. During both seasons of the year, no coliform bacteria were recorded from the source up till a distance of 50m from the source. The results of the analysis also revealed that the spring water was of better quality than the well water as a result of high concentration of some contaminants present in the well water. The conclusion drawn from this study is that the warm spring water is of better quality than normal ground water in the town and is safe for human consumption without treatment if properly protected and collected.

Keywords: Ikogosi, Warm spring, Water analysis, Ground water, South Western Nigeria.

INTRODUCTION

Water is believed to be the most important natural resource in the world since without it; man cannot survive in his natural environment. From the beginning of civilization, man's utmost priority has been the search for clean and environmental friendly source of water. Although from earliest times, man has made several attempts to provide his community with safe potable water, it was not until two centuries ago that water engineers and scientists were able to develop some basic standards for potable or drinking water through thorough physical, chemical and bacteriological examinations of water. Water for human consumption must be free from all objectionable odour, turbidity, taste, enteric pathogenic bacteria or

their indicators and must not fluctuate in its quality [1]. In safeguarding public water supplies therefore, public health authorities and engineers rely on information obtained from the results of frequent bacteriological test [2].

According to WHO (2004) [3] about 5 million children die annually from diseases contacted through unsafe drinking water annually and 1/6th of the world population fall sick as a result of consuming unwholesome water .WHO and UNICEF Joint Monitoring Program estimates that 1.1 billion people (17%) of the global population lack access to water resources, where access is defined as the availability of at least 20 liters of water per person per day from an improved water source within a distance of 1 km [4] . According to the International Monetary Fund, IMF (2003) [5] growing water scarcities and water pollution in developing and developed countries alike have plunged the world into a water crisis.

Groundwater is an important water resource in both the urban and rural areas of Nigeria but in the cities, pipeborne water is also available [6]. Majority of the rural populace in Nigeria do not have access to potable water and therefore, depend on well, stream and river water for domestic use [7]. Ground water resources are under threat from pollution due to human life style manifested by the low level of hygiene practiced in the developing nations [8], [9]. Spring water is relatively pure and can be used without treatment provided the spring is well protected from contamination. Springs may be contaminated at the point where the spring emerges from the ground. Springs that draw water from sources close to the ground surface are more likely to be contaminated than springs that draw water from deep underground source. In general, the quality of water from streams, rivers, ponds and lakes is of less quality than water from springs.

A warm spring is a thermal spring that is produced by the emergence of geothermal heated ground water from the earth's crust. Several stories have been told about the origin of warm springs. The most scientific of them is that the deeper a body of water goes underground, the hotter it becomes and if by chance it is forced back to the surface through some earth fault, the temperature becomes relatively high. There are warm springs in all continents and in many countries of the world. In Nigeria, the town of Ikogosi is renowned as home of the famous Ikogosi warm spring. The Ikogosi warm spring is located in Ekiti State. It is about 55km and 1 hour drive from Akure, the capital of Ondo State. The warm spring rolls down over a hilly landscape and join the cold spring from another hill at a depth of 100m below to form a continuous stream. The stream resulting from the mixing of the warm spring and the cold stream, tributary of the Owena River used to be the major source of the cooking and drinking needs of the over 30,000 inhabitants of Ikogosi-Ekiti. The popular Gossy water is a product of Ikogosi Warm Spring. Apart from drinking purposes, the warm spring also serves as a holiday resort for tourists.

The curiosity to assess the quality of Ikogosi warm spring was borne out of the fact that potable water is as scarce as gold in Nigeria. Potable water is a major problem in urban centers in Nigeria. Less than 50 percent of the Nigerian population, apart from those who are able to afford the luxury of sinking a bore-hole in their personal residences, have access to good drinking water [10] . In Nigeria, the dependence on drinking water contaminated with all sorts of bacteria, germs and suspended matter capable of causing diseases, is still the lot of the majority [11]. For decades, communities have been in the habit of utilizing springs in their vicinity as a source of potable water. However, Government does not concern itself with the water quality or yield of springs, particularly in light of rapid urbanization which is associated with a variety of pollutants through seepage and underground infiltration [12]. Some springs in Nigeria have been developed as centers of tourism thereby affecting the water quality of such springs. Due to tourist and other recreational activities and its inherent health problems, it is imperative to access the quality of the Ikogosi warm spring water.

Oladipo et al. (2005) [13] had earlier carried out a chemical examination of Ikogosi warm spring, the result of his analysis revealed that notable increase in the values of some its chemical composition could be attributed to environmental contributions to water quality degradation. A chemical analysis of water is a necessary indicator of determining the quality and portability of water but not sufficient. Physical, chemical and

bacteriological analyses are necessary and sufficient for the determination of water quality. Hence the need to carry out this study. Water samples for laboratory analysis were collected from 12 points in Ikogosi warm spring and 1 shallow well in Ikogosi town. Water samples were collected in February and July 2008 covering both the dry and wet seasons.

MATERIALS AND METHOD

Sampling Technique: Water samples for the physical and chemical analysis were collected in 1 liter plastic bottles. For the bacteriological analysis, water samples were collected in sterile bottles. The bottom of the sterile bottles was held with gloved hands, the mouth of the bottles was tilted to face the direction of flow and the bottles were covered immediately after the samples were collected.

Laboratory analysis commenced soon after sample collection in order to avoid changes that may occur in the water samples. Prior to the commencement of analysis, the water samples were kept at 4^{o}C. A total of 26 water samples were collected covering both the raining and dry seasons. This was done in order to ascertain the variation in the quality of the spring water during the two different seasons of the year**.** Standard guidelines in [14] were used in the analysis.

Sample Location: Water samples were collected from eleven points within the site of the warm spring. A sample was collected at the meeting point of the warm and cold stream; a sample was also collected from a well in Ikogosi town.

The cpllection points are summarized as; (a) Varying points along the course of the warm spring at intervals of 10m, (b) The meeting point of the warm and cold streams. (c) A shallow well in the middle of Ikogosi town.

RESULTS AND DISCUSSION

Results of Water Analysis: The results of the physical, chemical and bacteriological analysis carried out on the water samples in February, 2008 marking the peak of the dry season is presented in Table 1. Table 2 presents the results of the laboratory tests carried out on the water samples in July 2008 marking the peak of the raining season while Table 3 presents WHO and SON drinking water standards.

The average temperature of the warm spring water taken at different points of 10m interval was 35.9^{o}C during the dry season (February) and 35.7^{o}C during the wet season (July).

This can be traced to the fact that circulation of normal ground water to a depth of one to several feet increases the temperature of water. Rogers et al., (1969) [15] reported similar incidence. Figure 1 shows the variation of Temperature at various points in the warm spring and a well in Ikogosi town during the two seasons of the year.

The values of the total dissolved solids for the well water samples for both the dry and wet season were higher than that of the warm spring and its meeting point with the cold stream as shown in Figure 2. This is in spite of the fact that the warm spring water had an average temperature that was higher than that of its meeting point with the cold stream and that of the well water. This did not corroborate the conclusion of Oladipo et al. (2005) [13] that the solubility of most salts tends to increase with temperature.

A wide range of total hardness was observed in the water samples collected from the warm spring during the two seasons of the year. In the dry season, a total hardness range of 9.4 to 11.8 mg/l was observed while a total hardness range of 9.2 to 11.6 mg/l was recorded during the wet season. The results show that the warm spring water was slightly harder during the dry season that the wet season. The total hardness of the well was 28 mg/l and 33mg/l for the dry and wet season respectively. The calcium and magnesium hardness varied significantly also.

Table 1: Results of analysis of water samples collected from Ikogosi warm spring and a well in the middle of Ikogosi town for the month of February 2008 (dry season).

Sample Parameter	**Source**	**10m**	**20m**	**30m**	**40m**	**50m**	**60m**	**70m**	**80m**	**90m**	**100m**	**Meeting Point (104.8m)**	**Well**	**WHO Guideline**
Temperature	37.5	37.2	37.0	36.8	36.5	36.2	35.7	35.6	35.1	34.8	34.7	32.5	28.1	-
pH value	6.70	6.90	7.10	7.20	7.40	7.30	7.50	7.70	7.60	7.70	7.80	7.80	7.70	6.5 - 8.5
Turbidity (NTU)	0.9	1.0	1.1	1.1	1.1	1.0	1.1	1.1	1.2	1.2	1.2	1.2	2.7	5.0
Conductivity (µS/cm)	312.0	322.4	329.2	333.6	351.4	351.0	356.2	371.4	384.8	368.2	373.8	352.6	430	1000
Total Dissolved Solids (mg/L)	156.0	161.2	164.6	166.8	175.7	175.5	178.1	185.7	192.4	184.1	186.9	176.3	215.0	500
Alkalinity (g/L)	9.0	10.0	10.0	9.0	10.0	10.0	12.0	12.0	12.0	16.0	14.0	12.0	18.0	-
Total Hardness	9.4	9.7	9.8	10.1	10.4	10.2	11.4	11.7	11.8	12.1	12.2	12.4	28.0	100
Calcium Hardness(mg/L)	2.4	2.3	2.2	2.4	2.4	2.1	2.4	2.4	2.8	2.7	2.8	2.8	8.4	-
Magnessium Hardness(mg/L)	7.0	7.4	7.6	7.7	8.0	8.1	9.0	9.3	9.0	9.4	9.4	9.6	19.6	-
Chloride(mg/L)	7.2	7.5	7.8	8.0	9.0	8.0	9.0	9.5	10.0	10.8	10.7	10.9	29.0	250
Nitrite(mg/L)	0.010	0.027	0.036	0.041	0.042	0.040	0.048	0.059	0.076	0.081	0.084	0.086	0.10	45
Sulphate(mg/L)	0.54	0.75	0.84	0.90	0.93	0.97	1.0	1.20	1.50	1.67	1.77	1.90	1.91	200
Iron(mg/L)	0.13	0.17	0.21	0.21	0.21	0.21	0.22	0.25	0.25	0.27	0.30	0.30	0.63	0.3
Manganese(mg/L)	0.010	0.019	0.020	0.021	0.024	0.023	0.031	0.042	0.038	0.036	0.042	0.077	0.934	0.1
Lead(mg/L)	0.003	0.007	0.006	0.008	0.007	0.005	0.008	0.007	0.006	0.009	0.012	0.014	0.038	0.01
Cadmium(mg/L)	0.002	0.003	0.003	0.005	0.004	0.003	0.004	0.005	0.004	0.005	0.007	0.008	0.028	0.005
Total Coliform (MPN/100mL)	0	0	0	0	0	1	1	2	3	3	4	4	7	10
Escherichia coli (MPN/100mL).	0	0	0	0	0	0	0	1	1	1	1	1	4	Less than 1

Source: Field Survey, 2008

(All units are in milligrams per liter (mg/L) unless otherwise stated. Milligrams per liter are equivalent to parts per million; **NTU** - Nephelolometric Turbidity Units; **MPN** - Most Probable Number; **WHO** - World Health Organization)

Table 2: Results of analysis of water samples collected from Ikogosi spring warm and a well in the middle of Ikogosi town for the month of July 2008 (wet season).

Sample Parameter	Source	10m	20m	30m	40m	50m	60m	70m	80m	90m	100m	Meeting Point (104.8m)	Well	WHO Guideline
Temperature	37.3	37.1	36.8	36.6	35.9	35.7	35.6	34.9	34.7	34.5	34.4	31.0	27.6	-
pH value	7.0	7.0	7.1	7.3	7.5	7.4	7.5	7.7	7.7	7.8	7.9	7.9	7.6	6.5 - 8.5
Turbidity (NTU)	1.0	1.0	1.0	1.1	1.1	1.0	1.1	1.1	1.2	1.2	1.3	1.4	2.0	5.0
Conductivity (µS/cm)	306.2	312.4	329.2	338.8	352.4	350.0	359.8	360.6	370.2	360.0	358.8	343.6	370	1000
Total Dissolved Solids (mg/L)	153.1	156.2	164.6	169.4	176.2	175.0	179.9	180.3	185.1	180.0	179.4	171.8	186.5	500
Alkalinity (g/L)	10.0	10.0	16.0	14.0	10.0	8.0	10.0	12.0	12.0	18.0	16.0	12.0	16.0	-
Total Hardness	9.2	9.7	9.7	10.4	10.0	9.5	10.0	10.4	10.6	11.4	11.6	11.2	33.0	100
Calcium Hardness(mg/L)	2.1	2.0	2.7	2.4	2.8	2.8	2.2	2.2	2.4	2.4	2.4	2.6	9.2	-
Magnessium Hardness(mg/L)	7.1	7.8	7.0	8.0	6.2	6.8	7.8	8.2	8.2	9.0	9.2	8.6	23.8	-
Chloride(mg/L)	7.0	7.4	8.3	8.5	8.5	7.5	8.8	9.0	9.3	9.7	10.0	10.0	22.0	250
Nitrite(mg/L)	0.010	0.071	0.069	0.074	0.071	0.059	0.066	0.067	0.081	0.079	0.084	0.09	0.10	45
Sulphate(mg/L)	0.84	0.93	0.90	0.96	0.97	0.96	1.0	1.17	1.24	1.33	1.37	1.82	1.91	200
Iron(mg/L)	0.15	0.19	0.20	0.22	0.23	0.22	0.24	0.23	0.24	0.25	0.26	0.29	0.77	0.3
Manganese(mg/L)	0.012	0.021	0.023	0.024	0.033	0.029	0.042	0.021	0.054	0.031	0.044	0.082	1.064	0.1
Lead(mg/L)	0.003	0.005	0.008	0.008	0.008	0.005	0.006	0.008	0.007	0.008	0.012	0.015	0.035	0.01
Cadmium(mg/L)	0.001	0.001	0.001	0.002	0.003	0.002	0.003	0.002	0.003	0.004	0.005	0.005	0.026	0.005
Total Coliform (MPN/100mL)	0	0	0	0	0	1	2	2	3	4	4	5	8	10
Escherichia coli (MPN/100mL).	0	0	0	0	0	0	0	1	1	1	1	1	5	Less than 1

Source: Field Survey, 2008

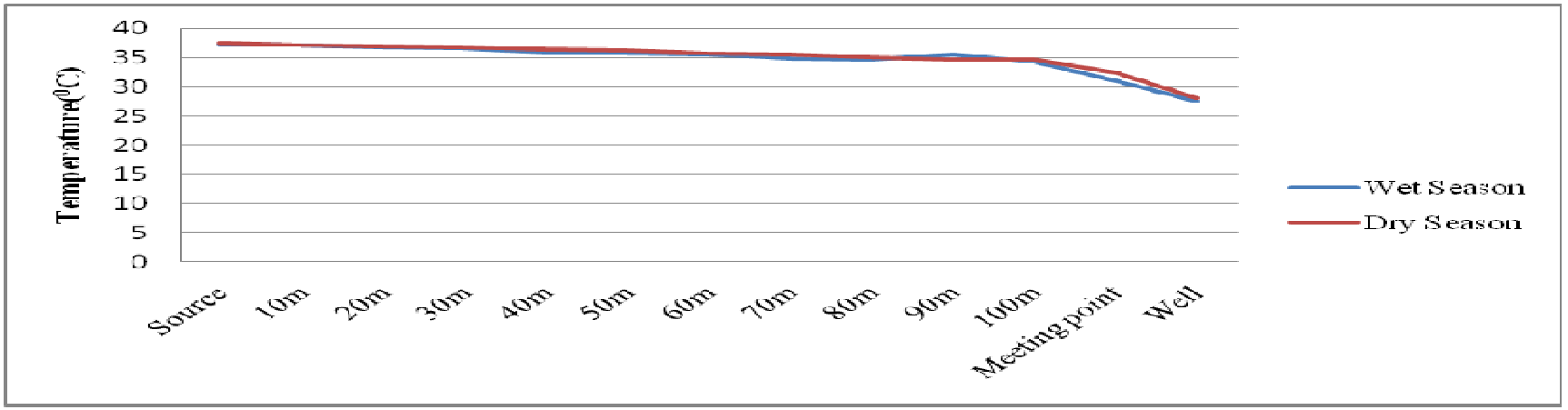
(All units are in milligrams per liter (mg/L) unless otherwise stated. Milligrams per liter are equivalent to parts per million; **NTU** - Nephelolometric Turbidity Units; **MPN** - Most Probable Number; **WHO** - World Health Organization)

During the dry season, a calcium hardness range of 2.0 – 2.6 mg/l and a magnesium hardness range of 7.0 – 10.0 mg/l were recorded. The calcium and magnesium hardness of the well water sample collected during the dry season was 8.4 and 19.6 mg/l respectively. During the wet season, a calcium and magnesium hardness range of 2.0 to 2.4 mg/l and 6.8 to 9.22 mg/l respectively was recorded. The calcium and magnesium hardness of the well water collected during the wet season was 9.2 and 23.8 mg/l respectively. The values obtained for calcium and magnesium hardness as well as chloride, sulphate and the heavy metals which include Iron, Manganese, Lead and Cadmium in the warm spring water during both seasons of the year could be due to the abundance of Hot Dry Rocks aroundthe spring area. The conclusion was in tune with findings of Adegbuyi et al. (1996) [16] and Ajayi et al. (1996) [17]. Figures 3 and 4 shows the variation of Calcium hardness with Magnesium hardness at various points in the warm spring and a well in Ikogosi town during the dry and wet seasons respectively.

Analysis of the bacteriological quality of the Ikogosi warm spring water was conducted to assess possible health risk associated with consumption of the spring water. The results of the analysis showed the presence of total coliform and e-coli in the water samples collected from some points on the warm spring. In comparison to WHO and SON water quality standards, the total coliform and e-coli count of the warm spring water collected from most points on the warm spring fell within maximum permissible health limits.

Results of the bacteriological analysis revealed a total coliform range of 0 to 4 MPN/100ml and an e-coli range of 0 to 1 MPN/100ml for the water samples collected from the warm spring during the dry season. During the wet season, a total coliform and e-coli range of 0 to 5 MPN/100ml and 0 to 1 MPN/100ml respectively was recorded for the water samples collected from the warm spring. The well water sample had a total coliform and e-coli count of 7 and 5 MPN/100ml respectively during the dry season 8 and 5 MPN/100ml respectively during the wet season. The presence of coliform bacteria in the water at some distance from the warm spring source might be due to the fact that the spring water serves as recreational water and this type of water may contain pathogens. This is in tune with findings of Famurewa, O. (2001) [18] . The results of the bacteriological analysis showed that water at the source is very pure and free from bacteriological organisms. As it moves down the warm spring, the bacteriological quality deteriorates.

Figure 1: Variation of Temperature at various points in the warm spring and a well in Ikogosi town during the two seasons of the year.



During both seasons of the year, no coliform bacterium was recorded from the source up till a distance of 50m from the source. The results obtained from the laboratory analysis did not show any sameness of the warm spring water with normal ground water of Ikogosi town. This is at variance with the conclusion of Rogers et al. (1969) [15]. The well water samples contained more coliform bacteria than the spring water samples. Bacteria may be introduced into the well water through the method used in collecting water from it.

Figure 2: Variation of Total dissolved solids at various points in the warm spring and a well in Ikogosi town during the two seasons of the year.

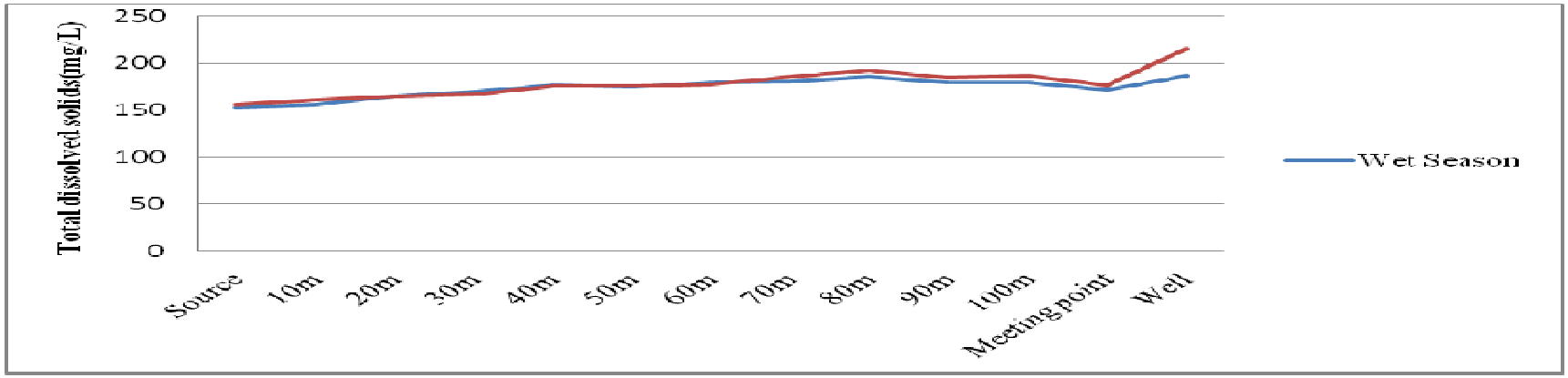


Figure 3: Variation of Calcium hardness with Magnesium hardness at various points in the warm spring and a well in Ikogosi town during the dry season.

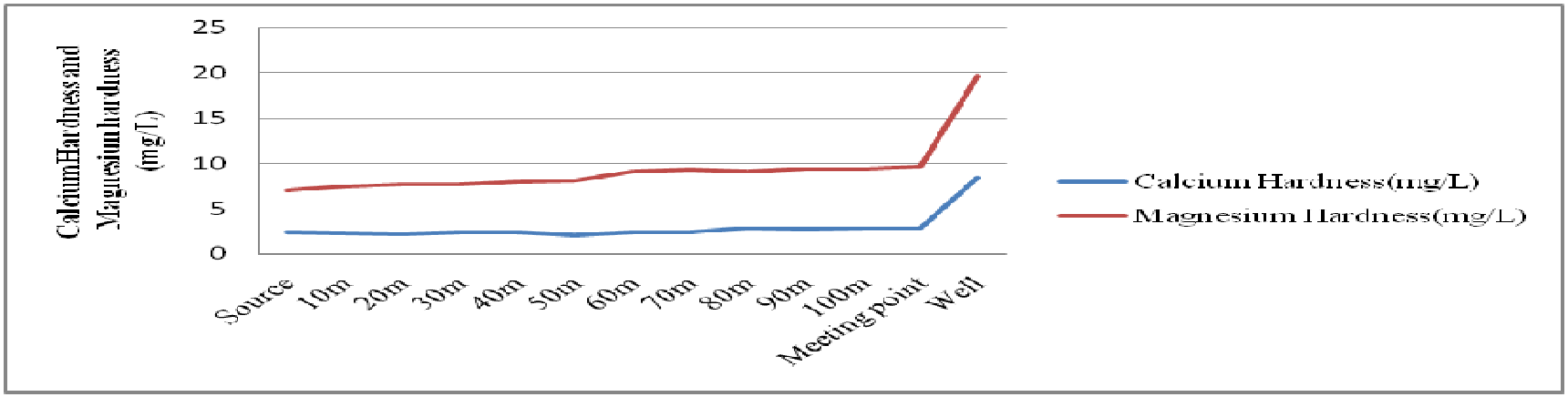
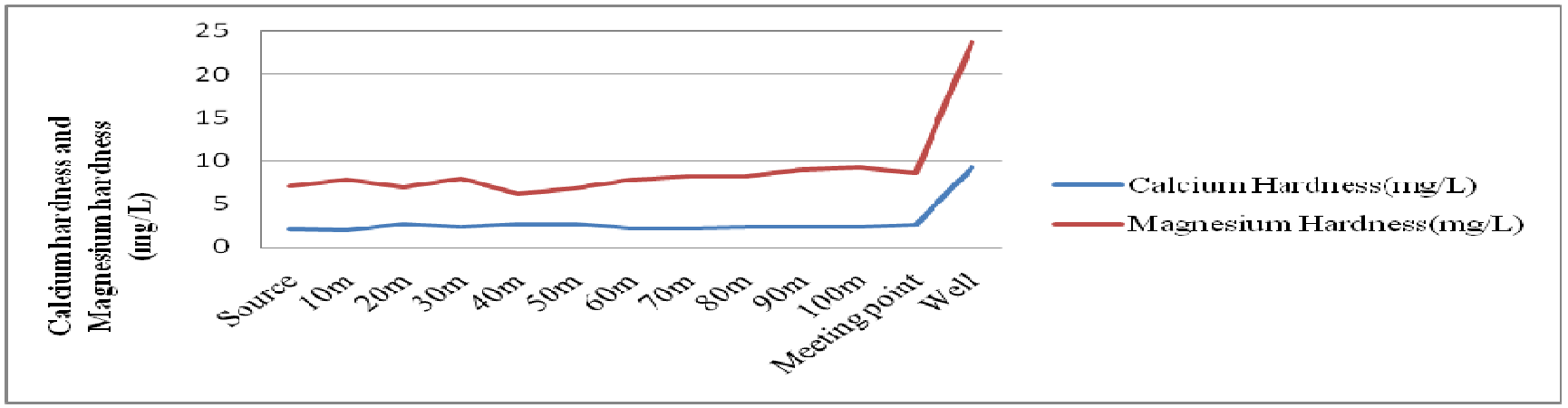


Figure 4: Variation of Calcium hardness with Magnesium hardness at various points in the warm spring and a well in Ikogosi town during the wet season.



CONCLUSION RECOMMENDATIONS

The laboratory analysis of water samples collected from various points on the warm spring and a well within Ikogosi town revealed that measured levels of all chemical composition fell within WHO permissible levels for drinking water. The variation in the chemical composition of the water as it flows from point to point on the warm spring could be as a result of the various chemical reactions that take place in the water [13].

An interesting feature of the warm spring water was its bacteriological composition. Total coliform and e-coli bacteria were present at some points on the warm spring. The laboratory analysis also revealed that the warm spring water was of better quality than the well water located in the middle of Ikogosi town.

In view of these, the following conclusions were drawn; from the results of the chemical analysis, it is fair to conclude that Ikogosi warm spring water is of good quality and can serve as a good source of potable water; since coliform bacteria were present at some points on the warm spring, there may be need to remove this potential source of health risk; a number of differences occurred between the spring water and the well water in the middle of Ikogosi town, therefore, the quality of the warm spring water varies from that of the normal ground water of the area; spring water remains one of the purest forms of water if properly protected and developed.

The following recommendations have been drawn from the conclusions above; the warm spring water should be properly developed and protected from potential sources of contamination such as introduction of faecal organisms by tourist activities; the bacteriological quality of the Ikogosi warm spring water can be improved by introducing water treatment methods in order to make the water at every point of the warm spring conform to WHO and SON standards and alternatively, tourists and other recreational activities should be restricted from certain sections of the warm spring so that water from such sections can be used solely for drinking purposes.

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