

## Assessment of physico-chemical properties of ground water samples collected from Jaipur, Rajasthan, India

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Available online at: [www.isca.in](http://www.isca.in), [www.isca.me](http://www.isca.me)

Received 8<sup>th</sup> April 2017, revised 14<sup>th</sup> July 2017, accepted 20<sup>th</sup> July 2017

### Abstract

The ground water samples have been collected from different localities of Jaipur district. The collected samples were analyzed for various physico-chemical parameters viz. total hardness, pH, Electrical conductivity, Alkalinity, Dissolved Oxygen, Chlorides, Phosphates, Sulphates, Fluorides, Cadmium (Cd) and Lead (Pb) by different analytical techniques. It has been found that the concentrations of maximum parameters are under the permissible limits. None of the water sample contains phosphate contents. The cadmium concentrations have been found in the samples collected from Shahpura, Chandwaji, NIMS University, Kukas, Gandhi Nagar, and Sitapura areas of Jaipur district. In these six samples Cadmium level was found above the desired limit (0.003 mg/l). Lead concentrations have been found above the desired limit (0.01 mg/l) in samples collected from NIMS University, Kukas, Malviya Nagar, Sitapura areas of Jaipur.

**Keywords:** Physico-chemical, Ground water, Jaipur, Atomic Absorption Spectrometry, UV-Vis Spectrophotometry.

### Introduction

Water, a universal solvent<sup>1</sup> and one of the important constituent for all living organism to survive their life on earth. Without water, our entire living world-plants, animals and humans are dead<sup>2</sup>. Earth is the only planet in the universe covered about 70% of its area with water but about 2.5% of the entire water is only fresh water and rest of the water is saline. Worldwide, more than one third of water used by humans comes from ground water. It is believed that ground water is one of the pure and clean form of fresh water which is drinkable.

India, a second largest populated country in the world where ground water is the major source of drinking water supply. WHO reports says that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water<sup>3</sup>. There are many factors which affect the quality of ground water<sup>4</sup>. The quality of ground water is affecting due to rapid increasing of population, urbanization, industrialization and use of fertilizers in the agriculture fields leads to water borne diseases<sup>5,6</sup>. Therefore it is always needed to check regularly the ground water quality because groundwater comes out through various conditions<sup>7-13</sup>. Many unseen dissolved mineral and organic constituents are present in ground water in various concentrations<sup>14</sup>. Water typically is not considered desirable for drinking if the quantity of dissolved minerals exceeds 1,000 mg/l. Water with a few thousand mg/l of dissolved minerals is classed as slightly saline but it is sometimes used in areas where less mineralized water is not available. Physicochemical characteristics of the water can change due to the mixing of different kinds of pollutants through sewage, industrial effluents, and agricultural runoff etc.<sup>6</sup>.

Rajasthan is the desert state of India having 10 % of country's land mass while 1.1% of surface water. Due to that ground water is the only drinking water source in Rajasthan which is also depleting. In Rajasthan, about 88% of water is highly saline while 55% contain fluoride<sup>15</sup>. Several studies on ground water quality at different localities in Rajasthan have been done by many researchers<sup>15,16</sup>.

In the present study, physico-chemical assessment of ground water samples from different localities of Jaipur was determined using standard analytical methods.

### Materials and methods

**Collection of water samples:** The various ground water samples were collected from Shahpura, Chandwaji, NIMS University, Labana, Kukas, Badi Chaupar, Jhalana Doongri, Ghandhi Nagar, Malviya Nagar and Sitapura areas of Jaipur District. At least three samples from different sources of ground water were collected from each site to get exact result. The collected samples were analyzed for various parameters viz. Total hardness, pH, Electrical conductivity, Alkalinity, Dissolved Oxygen, Chlorides, Phosphates, Sulphates, Fluorides, Cadmium and Lead by different analytical techniques.

**Total Hardness:** The total hardness was determined by complexometric titration using EDTA and Eriochrome black T indicator until colour changes from purple to blue.

**Dissolved Oxygen (DO):** Dissolved oxygen (DO) is very important for living organisms to maintain their biological

process. Determination of dissolved oxygen was done by using sodium thiosulphate solution and manganese sulphate solution.

**Determination of pH:** pH was determined by electrometric method i.e. pH meter (ME 962-P, Max Electronics, India) using standard buffer solutions.

**Determination of Sulphate, Phosphate and Fluoride:** The concentration of Sulphate, Phosphate and Fluoride ions in the samples were determined by UV-Visible spectrophotometer (Systronics, Model 2202) using standard solutions.

**Determination of Alkalinity:** Alkalinity in water is due to the presence of weak acids like hydroxides, carbonates and bicarbonates of potassium, sodium, magnesium, calcium and certain heavy metals. Alkalinity of all ground water samples were determined by the simple sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) titration in the presence of methyl orange and phenolphthalein indicators.

**Determination of Electrical Conductivity:** The conductivity of the all ground water samples were determined by Conductivity meter (LT-16, Labtronics) having cell constant 0.97 cm<sup>-1</sup>. Conductivity cell was rinse carefully by using distilled water and wiped with tissue paper before applying sample to measure conductance. After cleaning the cell, cell was dipped in a small beaker containing ground water sample. Conductance reading was noted down after setting constant. This process was repeated for the other samples.

**Determination of Lead (Pb) and Cadmium (Cd) metal ions:** The samples were digested using 2% HNO<sub>3</sub> and then analyzed by Atomic Absorption Spectrometer (Perkin-Elmer-Aanalyst-100, Germany) for lead and cadmium metals on air-acetylene flame at wavelengths 283.2 nm and 228.8 nm, respectively.

## Results and discussion

Ground water samples were collected from the selected sites in Jaipur, Rajasthan showing in Table-1 and Figure-1 and the physico-chemical parameters analyzed for these samples showing in Table-2. Figure 2(a) shows that the total hardness in water samples has been found in the range between 64 ppm and 392 ppm. All the values of hardness in all samples of Jaipur are observed within the permissible limits according to Bureau of Indian Standards (BIS) (Desirable limit: 200 ppm and permissible limit: 600 ppm)<sup>17</sup>. Five sites viz. Kukas (216 ppm), Badi Chopar (392 ppm), Malviya Nagar (336 ppm), Gandhi Nagar (288 ppm) and Sitapura (220 ppm) where the levels are slightly higher than the standard specifications (desired limit) but these values can be safe for drinking purposes as they may be extended upto 600 ppm specified in Indian Standards<sup>18</sup>. Dissolved Oxygen (DO) produces energy for growth and reproduction. The permissible limit for DO as per BIS/WHO is 6 mg/l<sup>18</sup>. Figure-2(b) shows the levels of DO in all samples where minimum level (2.8 mg/l) was found in the samples collected from Labana while maximum (3.7 mg/l) was observed in the samples collected from NIMS University.

**Table-1:** Sampling Sites selected for ground water analysis from Jaipur district.

S. No.	Sampling Sites
1	Ground water Shahpura (G.SH)
2	Ground water Chandwaji (G.CH)
3	Ground water NIMS University (G.NIMS)
4	Ground water Labana (G.LAB)
5	Ground water Kukas (G.K)
6	Ground water Badi chaupar (G.BC)
7	Ground water Jhalana doongri (G.JH)
8	Ground water Malviya Nagar (G.MN)
9	Ground water Gandhi Nagar (G.GN)
10	Ground water Sitapura (G.SI)

Phosphate concentration did not find in any water sample collected from different sites in Jaipur. Figure-2(c) shows the Chloride levels in various samples. The minimum concentration (45.26 mg/l) has been found in Sitapura and maximum level (430.43 mg/l) at the site of Malviya Nagar. The level of chloride has been found within the permissible limits (1000 mg/l) but in five samples the values have been found above desired limit (250 mg/l)<sup>17</sup>. Higher concentration of chloride can cause salty taste of water and high blood pressure. The concentration of sulphate for various ground water samples are summarized in Figure-2(d). The results show that the minimum level (44.88 mg/l) was found in the water samples collected from NIMS University whereas maximum level (197.6 mg/l) obtained from the samples of Kukas area of Jaipur but the values for all samples have been found within the desired (200 mg/l) and permissible limits (400 mg/l)<sup>17</sup>.

Figure-2(e) shows the fluoride level in water samples from selected areas and the concentrations have been found in the range between 0.15 mg/l and 1.4 mg/l. Most of the samples contained slightly lower fluoride level than desired limit (1.0 mg/l) while water samples collected from Badi Chaupar (1.2 mg/l), Malviya Nagar (1.4 mg/l) and Gandhi Nagar (1.1 mg/l) have slightly higher than desirable limit but less than permissible limit (1.5 mg/l). Increasing fluoride concentration can cause the brownish discoloration of teeth and bone damage. Figure-2(f) shows the pH levels in different water samples and it has been found that all the selected water samples are slightly alkaline in nature but all the samples are safe for drinking purposes as acceptable desired limit is upto 6.5-8.5 according to BIS<sup>19</sup>.

The concentrations of alkalinity in all the collected samples are shown in Figure-2(g). The minimum value of alkalinity is observed as 156 mg/L while the maximum value is 336 mg/L. The prescribed limit for alkalinity according to Indian Standards is 200 mg/l<sup>19</sup>. Alkalinity level was found above the desired limits for NIMS University (308 mg/l), Kukas (208 mg/l), Jhalana Doongri (276 mg/l), Malviya Nagar (260 mg/l), Gandhi Nagar (336 mg/l) and Sitapura (332 mg/l) sites but less than that of permissible limit (600 mg/l). Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solder or plumbing fixtures. The concentrations of cadmium in

all the water samples are summarized in Table- 2 and Figure 2(h). The cadmium concentration have been found in the samples collected from Shahpura, Chandwaji, NIMS University, Kukas, Gandhi Nagar, and Sitapura areas of Jaipur while samples collected from the Labana, Badi Chaupar, Jhalana Doongri and Malviya Nagar have no cadmium content. In these six samples cadmium level were found above the desired limit (0.003 ppm)<sup>17</sup>. Cadmium is highly toxic and can cause 'itai-itai' disease-painful rheumatic condition, cardio vascular system related problems, gastro intestinal upsets and hypertension.



Figure-1: Location map of Jaipur highlighting the ground water sites.

**Table-2:** Physico-Chemical parameters of ground water samples.

Sampling Sites	Total hardness (ppm)	Dissolved oxygen (ppm)	Phosphate (mg/l)	Chloride (mg/l)	Sulphate (mg/l)	Fluoride (mg/l)	pH	Alkalinity (mg/l)	Cadmium (mg/l)	Lead (mg/l)	Electrical conductivity (mhos/cm)
G.SH	64	3	NA	346	45.88	0.7	8.03	180	0.53	NA	0.912
G.CH	100	3.3	NA	119.8	88.17	0.15	7.51	196	1.8	NA	0.625
G.NIMS	200	3.7	NA	142	44.88	0.58	6.8	308	2.1	7.678	2
G.LAB	172	2.8	NA	110.93	181.6	0.78	7.25	156	NA	NA	2.8
G.K	216	3.1	NA	346.12	197.6	0.99	7.3	208	1.1	0.778	3.2
G.BC	392	2.9	NA	168	149.5	1.2	7.2	188	NA	NA	3
G.JD	168	3.2	NA	350.5	48.12	0.97	7.45	276	NA	NA	0.95
G.MN	336	3.4	NA	430.43	125.4	1.4	7.13	260	NA	20.67	1.8
G.GN	288	3.4	NA	337.25	173.2	1.1	7.38	336	14.9	NA	1.3
G.SI	220	3.6	NA	45.26	182.5	0.57	8.11	332	0.45	45.69	3.3

Figure-2(i) shows the lead content in various water samples and it shows that lead have been found in four samples collected from NIMS University, Kukas, Malviya Nagar and Sitapura. In all the four samples lead level were found above the desired limit (0.01 mg/l)<sup>17</sup> while samples collected from the Shahpura, Chandwaji, Labana, Badi Chaupar, Jhalana Doongri and Gandhi Nagar have no Lead content. In drinking water lead can be enter when service pipes having lead corrode, especially where the water has high acidity or low mineral content that corrodes pipes. In Sitapura and Malviya Nagar, high level of lead content might be possible due to existence of heavy industries. High content of lead can cause abdominal discomfort, irritability, anaemia and damage to kidneys. Figure-2(j) shows the values of electrical conductivity in water samples and also shows that the minimum (0.912 mhos/cm) value is observed at the site of Shahpura, whereas the maximum levels (3.3 mhos/cm) in the samples of Sitapura.

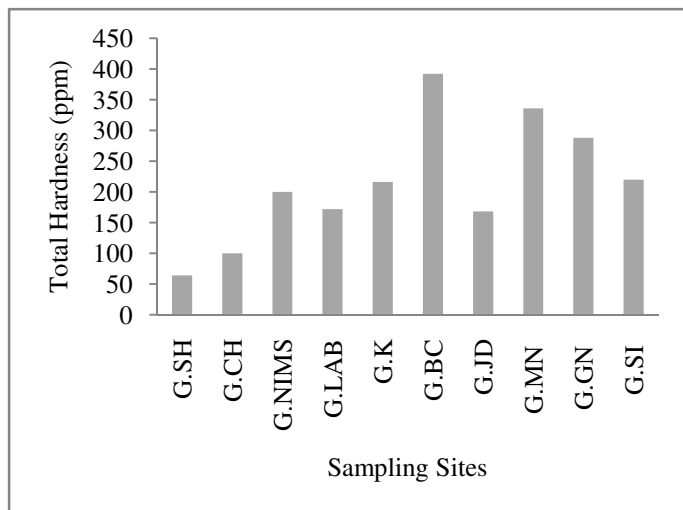
### Conclusion

The present study concluded that the total hardness in water samples has been found in the range between 64 ppm and 392 ppm. Values of hardness in all samples were observed within the desired limit except two sites viz. Badi Chaupar and Malviya Nagar where the levels are slightly higher than the standard specifications. The minimum dissolved oxygen levels were found in the sample of Labana while maximum DO level was observed in the samples of NIMS University. The minimum chloride concentration has been found in Sitapura and maximum at the site of Malviya Nagar. The levels of chlorides have been

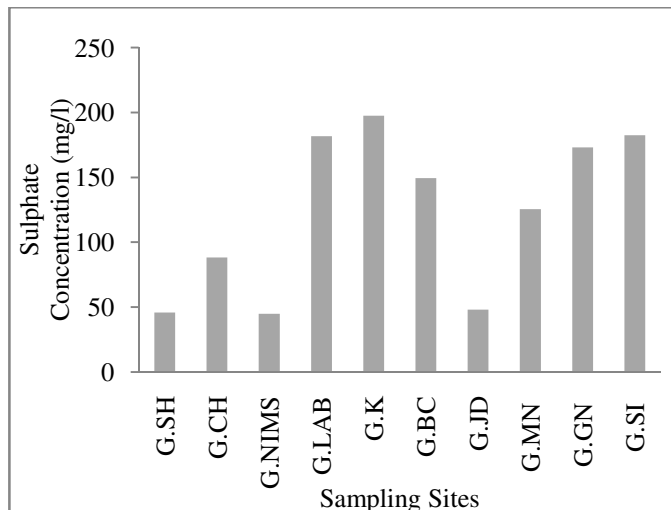
found within the permissible limits but in five samples the values have been found above the desired limit. The pH level in different water samples has been seen and found that water samples are slightly alkaline in nature but all the samples are safe for drinking purposes according to Indian Standards. The concentration of sulphate shows that the minimum level were found in the water sample collected from NIMS University whereas maximum levels are obtained from the samples of Kukas area of Jaipur but the values for all samples have been found within the permissible limits. The fluoride concentration was found within the permissible limits. The alkalinity levels are found above the permissible limits for NIMS University, Kukas, Jhalana Doongri, Malviya Nagar and Gandhi Nagar, Sitapura sites. The cadmium concentrations have been found in the samples collected from Shahpura, Chandwaji, NIMS University, Gandhi Nagar, and Kukas areas of Jaipur. In these samples, cadmium level is found above the permissible limit. Lead concentration has been found in samples collected from NIMS University, Kukas, Malviya Nagar and Sitapura areas of Jaipur. The minimum values of electrical conductivity were observed in the ground water samples from the site of Shahpura, whereas the maximum level in the samples of Sitapura area. None of the sample contains phosphate concentrations.

### Acknowledgement

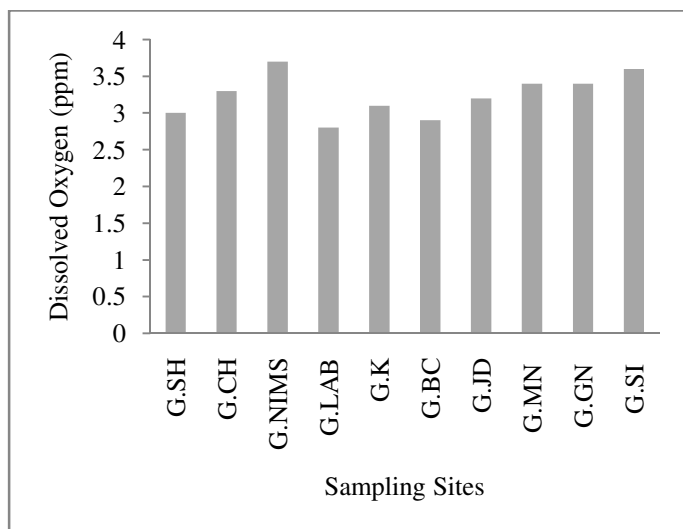
Authors are grateful to Department of Chemistry, St. John's College, Agra for providing UV-Vis Spectrometry and Atomic Absorption Spectrometry (AAS) facilities.



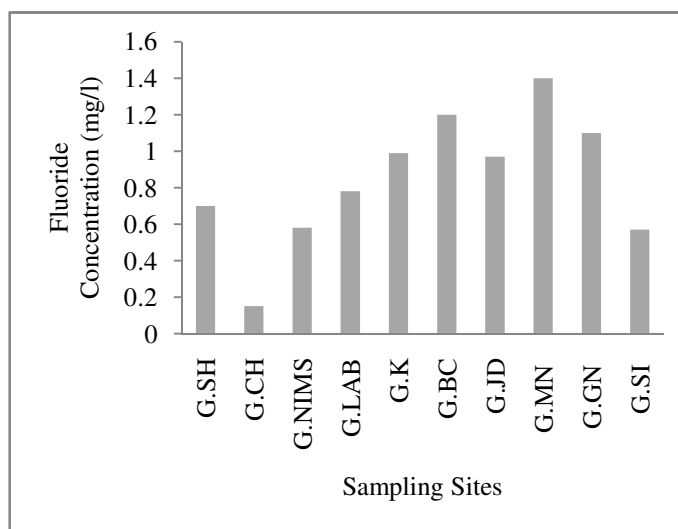
(a)



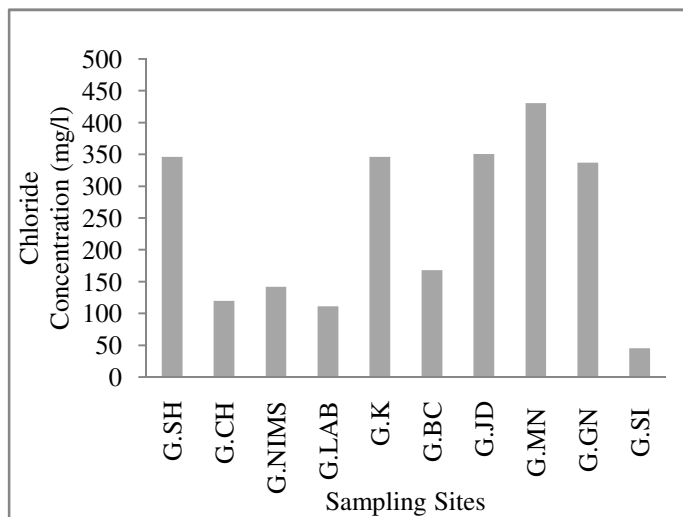
(d)



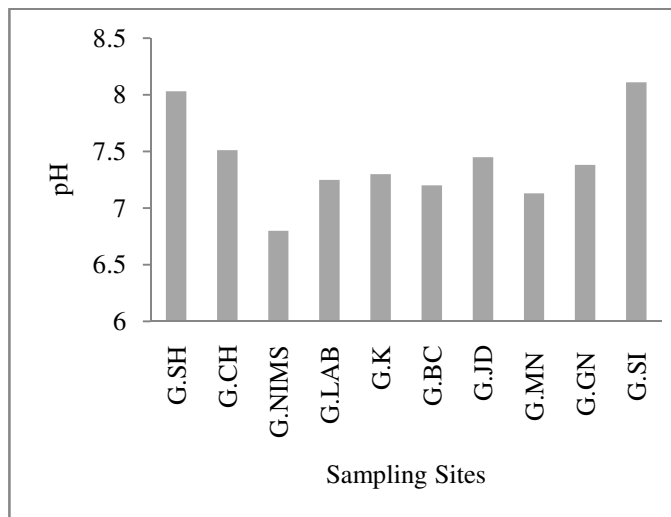
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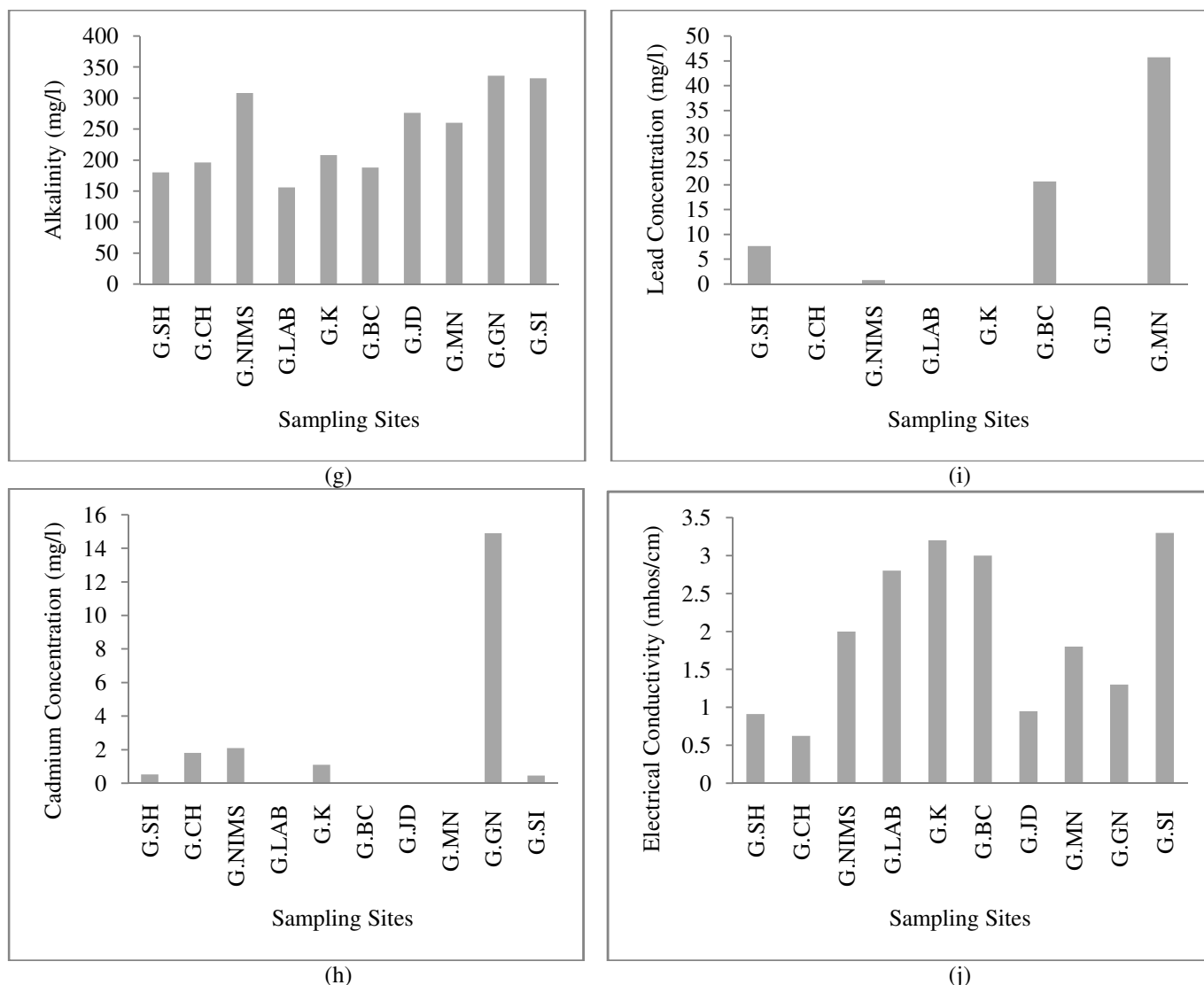
(e)



(c)



(f)



**Figure-2:** Physico-Chemical parameters of ground water samples collected from different sites in Jaipur; (a) Total Hardness, (b) Dissolved Oxygen, (c) Chloride Concentration, (d) Sulphate Concentration, (e) Fluoride Concentration, (f) pH, (g) Alkalinity, (h) Cadmium Concentration (i) Lead Concentration and (j) Electrical Conductivity.

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