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Estimation the levels of some heavy metals in the soil and vegetables irrigated with wells water in some agriculture fields at Al- Dora district – Baghdad

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Abstract

Heavy metals are currently of much environmental concern. The contamination by heavy metals in plants and water is one of the major issues to be faced throughout the world. This research is tried to estimate levels of heavy metals in vegetative crops and soil irrigated with well water (as alternative source for irrigation). Samples of well water, soil and vegetative crops were collected from agriculture fields at Al-Dora district in Baghdad. Physico-chemical parameters (pH, EC, TDS and Salinity) were measured for water and (pH, EC and salinity) for soil samples. Estimation of Lead (Pb), Nickle (Ni), Zinc (Zn) and Iron (Fe) concentrations in water, vegetable crops (*Raphanus sativus, Apium graveoleus, Beta vulgaris, Allium ampeloprasum, Lepidium sativum, Eruca sativa and Petroselinum hortense*) and soil samples were done. The results shows that the pH values ranged between 5.1- 6.4, EC 870-2760 µs/cm, TDS 430– 1390 mg/l and 0.5568- 1.7664 ppt for salinity of well water samples, while for soil samples the readings were 6.9-7.5, 200-1820 µs/cm and 0.128-1.1648 ppt for pH, EC and salinity, respectively. For heavy metals concentrations in wells water, the values were ranged between 1.636- 1.884 ppm, 1.068- 1.512 ppm, 0.292- 2.148 ppm and 1.404- 9.756 ppm for Pb, Ni, Zn and Fe, respectively. It was found that the samples of soil were contained Pb in the range 12.4- 58.2, Ni 144.5-214.83, Zn 83.07- 286.09 and Fe 16905.37- 22259.56 ppm, whereas the heavy metals concentrations in the vegetable crops were 0.92- 8.91, 11.78-82.82, 11.16- 77.44 and 628.44- 7977.07 ppm for Pb, Ni, Zn and Fe.

Keywords: metals, well water, agriculture fields

تقدير مستويات بعض العناصر الثقيلة في التربة والخضار المروية بمياه الابار لبعض الحقول الزراعية في منطقة الدورة – بغداد

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الخلاصة

اصبحت المعادن الثقيلة من المواضيع المهمة بيئيا في الوقت الحالي، وبات تلوث المياه والتربة والنباتات بالمعادن الثقيلة من المشاكل المهمة التي تواجه العالم. ولاهمية الموضوع بدأ السعي لعمل دراسات لتقدير المعادن الثقيلة في كل من المحاصيل الخضرية والتربة المروية بمياه الآبار (كمصدر بديل للسقي). جمعت عينات لكل من مياه الابار المستخدمة في الري والتربة والمحاصيل الخضرية من الحقول الزراعية لمنطقة الدورة في بغداد التي اختيرت كموقع للدراسة. درست الخصائص الفيزياوية والكيمياوية مثل قيمة الرقم الهيدروجيني والتوصيلية الكهربائية والمواد الصلبة الكلية والملوحة لعينات المياه المستخدمة في الري ،كما قيست قيمة الرقم الهيدروجيني والتوصيلية الكهربائية والملوحة لعينات التربة. وقدرت تراكيز العناصر الثقيلة

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كالرصاص والنيكل والزنك والحديد في عينات الماء والمحاصيل الخضرية (الفجل *Raphanus sativus*، كرفس *Apium graveoleus*، السلق *Beta vulgaris*، *الكرفس Apium graveoleus* ، الكراث *Allium ampeloprasum* ، الرشاد *Lepidium sativum*، الجرجير *Eruca sativa* و المعدنوس *Petroselinum hortense*). وعينات التربة قيد الدراسة. أظهرت النتائج لعينات مياه الآبار ان قيم الرقم الهيدروجيني تراوحت بين 5.1- 6.4، في حين تراوحت قيم التوصيلية الكهربائية بين 870- 2760 مايكروسمينز/سم، اما قيم المواد الصلبة الكلية فقد تراوحت بين 430 الى 1390 ملغم/ لتر وقيم الملوحة تراوحت بين 0.5568 الى 1.7644 جزء بالالف. بينما كانت نتائج العوامل الفيزياوية والكيمياوية للتربة كمايلي: قيمة الرقم الهيديروجيني تراوحت بين 6.9 الى 7.5 وتراوحت قيم التوصيلية الكهربائية بين 200 الى 1820 مايكروسيمنز/ سم، اما الملوحة فتراوحت قيمها بين 0.128 الى 1.1648 جزء بالالف. اما بالنسبة لتراكيز المعادن الثقيلة في مياه الابار فقد كانت 1.884 الى 1.636 و 1.068 الى 1.512 و0.292 الى 2.148 و 1.404 الى 9.756 جزء بالمليون، للرصاص و النيكل و الزنك والحديد، على التوالي. وجد ان محتوى عينات التربة بالنسبة للرصاص بين 12.4 الى 58.2 وتركيز النيكل 144.5 الى 214.83 والزنك 83.07 الى 286.09 والحديد 16905.37 الى 22259.56 جزء بالمليون. وكانت تراكيز الرصاص والنيكل والزنك والحديد في عينات المحاصيل الخضرية على التوالي هي 0.92 الى 8.91 و 11.78 الى 82.82 و 11.16 الى 77.44 و 628.44 الى 7977.07 جزء بالمليون.

Introduction

Heavy metals are currently of much environmental concern. They are harmful to humans, animals and are susceptible to bioaccumulation in the food chain. Heavy metals may come from many different sources in urban areas. Atmospheric pollution is a major contributor to heavy metal contamination in top soils [1]. Human activities such as industrial production, mining, agriculture and transportation, release high amounts of heavy metals into surface and ground water, soils and ultimately to the biosphere [2]. Accumulation of heavy metals in crop plants and agricultural soil is of great concern due to the probability of food contamination through the soil root interface [2, 3]. Ingestion of vegetables irrigated with waste water and grown in soils contaminated with heavy metals possesses a possible risk to human health and wildlife and heavy metal concentration in the soil solution plays an important role in controlling metal bioavailability to plants [2]. Heavy metals on the basis of their health importance can be classified into four major groups, as essential, like Cu, Zn, CO, Cr, Mn and Fe, which are micronutrients and are toxic when taken in excess [4,5], non-essential like Ba, Al, Li and Zr, less toxic like Sn and Al, and highly toxic like Hg and Cd. In small quantities, certain heavy metals are nutritionally essential for a healthy life. Some of these are referred to as the trace elements (e.g., iron, copper, manganese, and zinc). These elements, or some form of them, are commonly found naturally in foodstuffs, in fruits and vegetables, and in commercially available multivitamin products [6, 7]. In recent years many alternative ways for irrigation were found like, use of treated wastewater and well water because of drought and lack of rain season. Most of the studies show that the use of waste water and well water contaminated with heavy metals for irrigation over long period of time may be increases the heavy metal contents of soils above the permissible limit [2, 3, 4, 8, 9]. Ultimately, increasing the heavy metal content in soil also increases the uptake of heavy metals by plants depending upon the soil type, plant growth stages and plant species [2, 4, 8, 9]. This research aimed to investigate the heavy metals concentrations in soil and plant irrigated with wells water in some agriculture fields in Al- Dora district in Baghdad and does these concentrations at safe levels according to international standard limits, and safe to consume by human being.

Materials and Methods

Study area

For this study, agriculture fields at Al-Dora district which locate in south of Baghdad (N 33°12'29.96", E 44°23'43.76") were chosen to estimate the heavy metals concentrations of soil and vegetable crops samples which irrigated with wells water Figure -1.

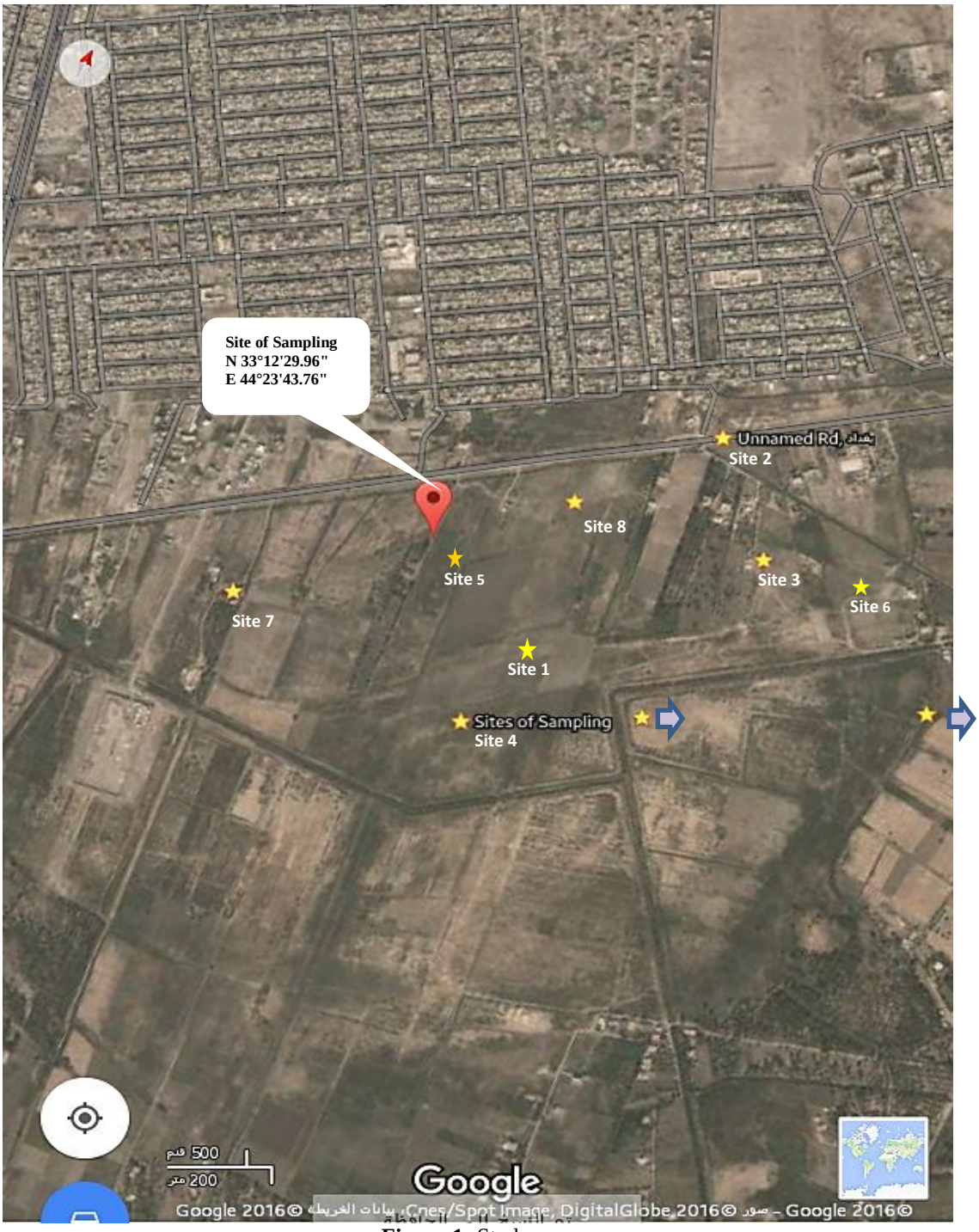


Figure 1- Study area

Collection of samples:

From April to May 2016, eight samples as duplicate of water, soil and plants which irrigated with well water were collected from 8 sites (8 farms) of study area at Al-Dora district Figure-1. Soil and plants (dominant plant) samples (*Raphanus sativus, Apium graveoleus, Beta vulgaris, Allium ampeloprasum, Lepidium sativum, Eruca sativa and Petroselinum hortense*) were randomly collected from agriculture area.

Sample treatment:

Water analysis:

Well water samples were divided into two parts one part for physical chemical parameters (pH, EC, TDS and salinity), the readings were taken with multimeter (HANNA- HI 9811-5) calibrated with

standard solutions, and second part were taken after wet digestion according to [10] for heavy metals estimation by flame atomic absorption spectrophotometer.

Soil analysis

Soil samples which collected from the surface (0-10 cm) were cleaned by removing roots and rocked particles, then oven dried at 75°C, grind by mortar, sieved by 212 µm sieve to get fine particles and take 3 gram of it, analyzed by x-ray fluorescent technique to estimate the heavy metals concentrations [11]. Soil physical and chemical parameters (pH, EC and Salinity) were measured according to Rhoades [12] method by making soil suspension 1:5 (soil: distilled water). Mixtures composed of 10 g of soil and 50 ml distilled water were shaken by shaker for 1 hr. [12]. The readings were taken with multimeter (HANNA- HI 9811-5) calibrated with standard solutions.

Plant analysis:

Plants samples (*Raphanus sativus* (site.1), *Apium graveoleus* (site.2), *Beta vulgaris* (site.3), *Apium graveoleus* (site.4), *Allium ampeloprasum* (site.5), *Lepidium sativum* (site.6), *Eruca sativa* (site.7) *and Petroselinum Hortense* (site.8)) which collected by plastic bags randomly from the agriculture field were air dried and oven dried at 50°C, then smashed by mortar and sieved with 212 µm sieve to get fine powder. 3 grams of this powder were taken to analyze by X-ray Fluorescence spectrometry to estimate the heavy metals concentrations in plant samples [11].

Results and discussion

Physical- chemical parameters of well water

Well water's physical-chemical parameters (pH, Electrical conductivity EC, salinity and Total dissolved solids TDS) are shown in Table-1.

Form Table-1 the pH values of the well water samples are varied between 5.1- 6.4. The highest value is 6.4 which recorded in St.6, while the lowest value was in St.4 which is 5.1. These values are under the permissible level of WHO which is 6.5-8.9. According to these results the well water is slightly acidic to neutral. The acidity of water may be return to the pipe used in water transfer or the nature of the soil and the source of water, in addition to ions of heavy metals water content. These results are lower than the mean values of pH in study of Rana, *et al.* [2] in India and Ezeribe *et al*. [13] in Nigeria which are 7.3 and 7.8, respectively. The conductivity (EC) readings are varied 870- 2760 µS/cm. the highest value is 2760 µS/cm were recorded in St.1 and the lowest value were recorded in S.2 which is 870 µs/cm. In all collected samples of well water the EC values are above the allowable limit of WHO which is 400-600 µS/cm. These results give a good indicator of the presence of contaminants such as sodium, potassium or sulphate, and the water is brackish [15]. These results are similar to the results of Nazir *et al.* [2] study, and dissimilar to EC values of Ezeribe, *et al.* [13] study. According to WHO [14] the well water samples is brackish, because the salinity maximum value is 1.7664 ppt which recorded in S.2 and the minimum value is 0.5568 ppt which recorded in St.1, the two readings are in limit of brackish water which is 0.5-17 ppt. Values of TDS in this study is varied between 430- 1390 mg/l. According to Fipps [15] classification for irrigation water the well water that used in irrigation is classified as permissible.

Table 1- Physical- chemical parameters in well water

Sites	pH	EC (µS/cm)	Salinity (ppt)	TDS (mg/l)
St.1	5.8	870	0.5568	430
St.2	5.8	2760	1.7664	1390
St.3	6.1	1620	1.0368	810
St.4	5.1	2410	1.5424	1200
St.5	6	1500	0.96	750
St.6	6.4	1480	0.9472	740
St.7	6.1	2540	1.6256	1270
St.8	6.4	1470	0.9408	740
WHO Standard	6.5-8.9	400-600		1000

Physical- chemical parameters of soil

Soil physical chemical parameters (pH, EC, and Salinity) are shown in Table-2. The pH values of soil samples are varied in range 6.9-7.5,the highest pH value were recorded in St. 5 and the lowest in St.6, while EC readings were 200-1820 µs/cm and salinity results were 0.128- 1.1648 ppt Table -2.

These values classify the soil as saline sodic soil according to Fipps classification [15], and give an indicator that these soil samples are rich with ions and heavy metals.

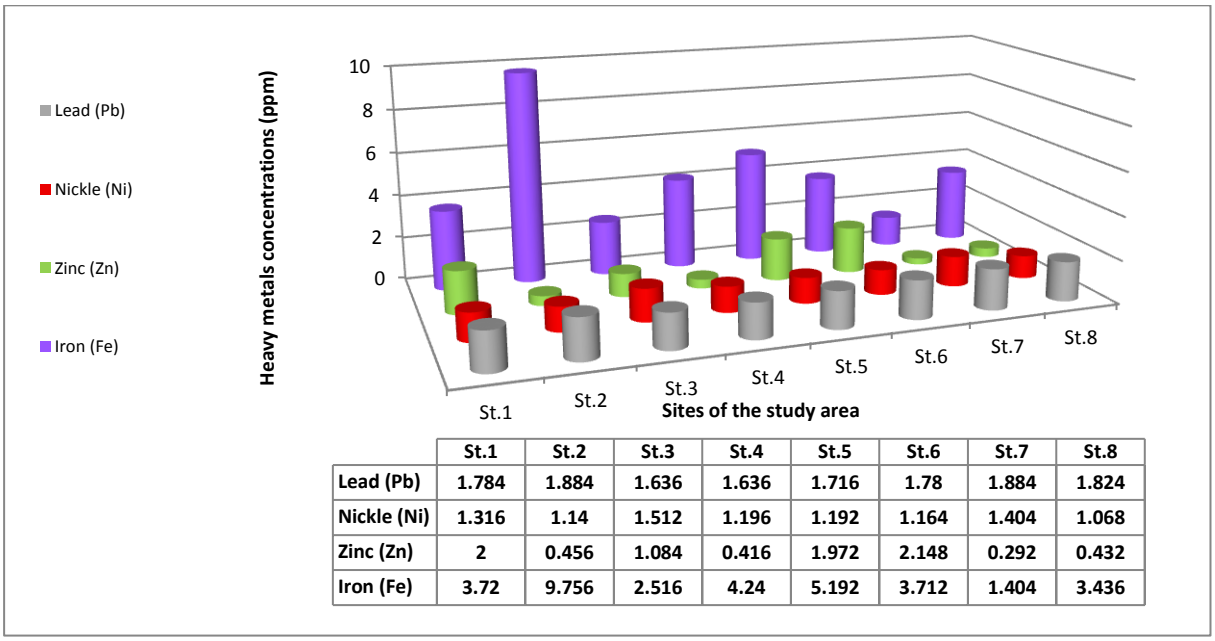
Table 2-Soil Physical- chemical parameters

Sites	pH	EC (µS/cm)	Salinity (ppt)
St.1	**7.2**	**220**	**0.1408**
St.2	**7**	**1820**	**1.1648**
St.3	**7.4**	**210**	**0.1344**
St.4	**7.3**	**200**	**0.128**
St.5	**7.5**	**300**	**0.192**
St.6	**6.9**	**1630**	**1.0432**
St.7	**7.4**	**590**	**0.3776**
St.8	**7.3**	**220**	**0.1408**

Heavy metals concentrations in samples of water, soil and vegetable crops of the study area

The values of heavy metals (Pb, Ni, Zn and Fe) in well water, soil and vegetative crops samples are shown in Figures-2, 3, 4, 5, and 6.

The values of Pb, Ni, Zn and Fe in **water samples** were varied from 1.636-1.884, 1.068-1.512, 0.292-2.148 and 1.404-9.756 ppm, respectively Figure-2. For water samples, all values of heavy metals are above the acceptable limits of WHO [15, 18] except for Zn value which is within the WHO levels. In this study the results of Pb and Ni in water samples are higher than the results of Lone *et al.* [9] for the same elements. Al- Jaboobi *et al.* [8] and Nazir *et al.* [2] results are less than the results of all heavy metals values under this study.

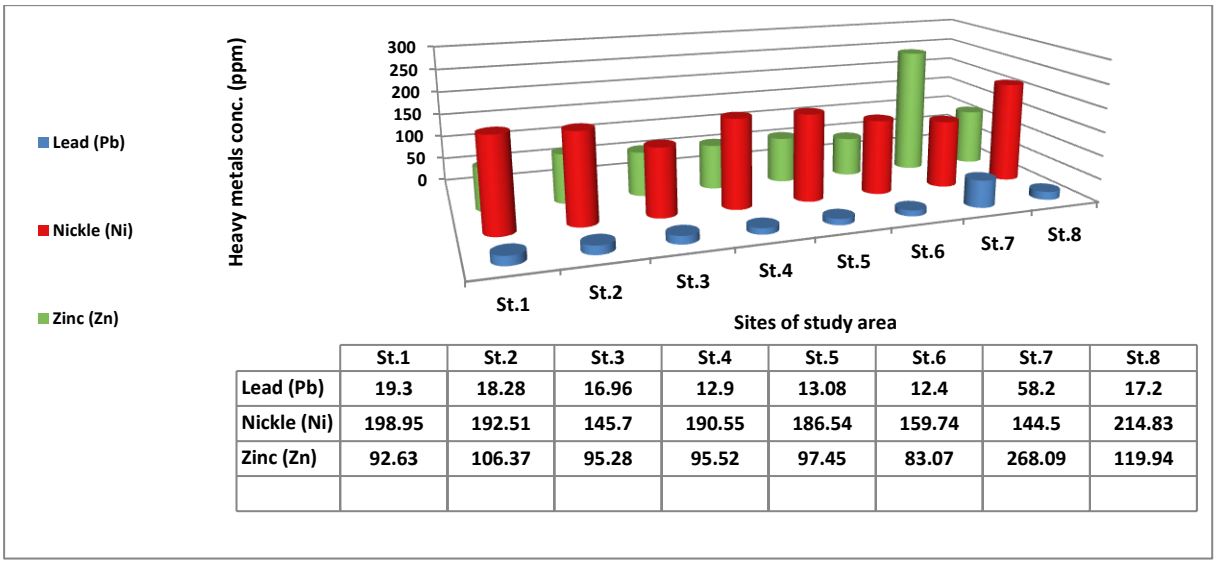


	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8
Lead (Pb)	1.784	1.884	1.636	1.636	1.716	1.78	1.884	1.824
Nickle (Ni)	1.316	1.14	1.512	1.196	1.192	1.164	1.404	1.068
Zinc (Zn)	2	0.456	1.084	0.416	1.972	2.148	0.292	0.432
Iron (Fe)	3.72	9.756	2.516	4.24	5.192	3.712	1.404	3.436

Figure 2- Heavy metals concentrations (ppm) in irrigated well water

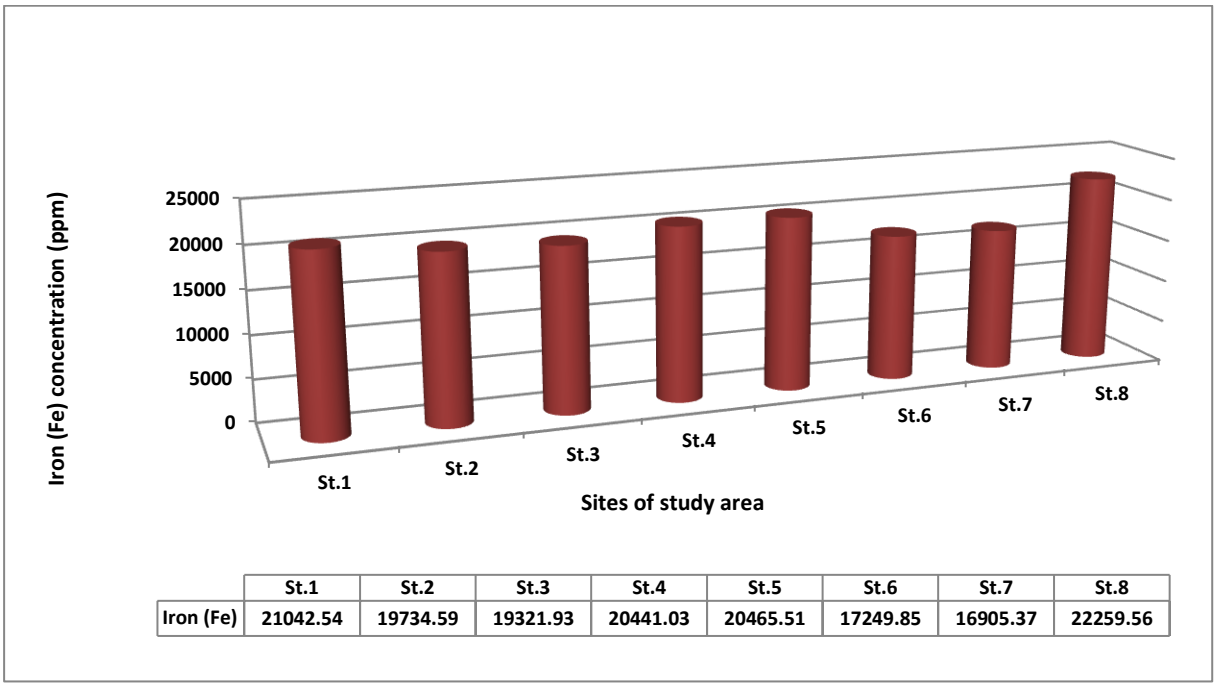
In soil samples Figures-2,- 3 the content of heavy metals (Pb, Ni, Zn and Fe) were varied from 12.4- 58.2, 144.5- 214.83, 83.09- 268.09 and 16905.37- 22259.56 ppm, respectively.

The soil samples content of Ni and Zn are within allowable limits of WHO [2, 11] while Pb and Fe is higher than WHO levels [2] and this may be due to nature of geological formation, low microbial activity and traffic pollutants emission.



	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8
Lead (Pb)	19.3	18.28	16.96	12.9	13.08	12.4	58.2	17.2
Nickle (Ni)	198.95	192.51	145.7	190.55	186.54	159.74	144.5	214.83
Zinc (Zn)	92.63	106.37	95.28	95.52	97.45	83.07	268.09	119.94

Figure 3- Heavy metals concentrations (ppm) in soil of agriculture area

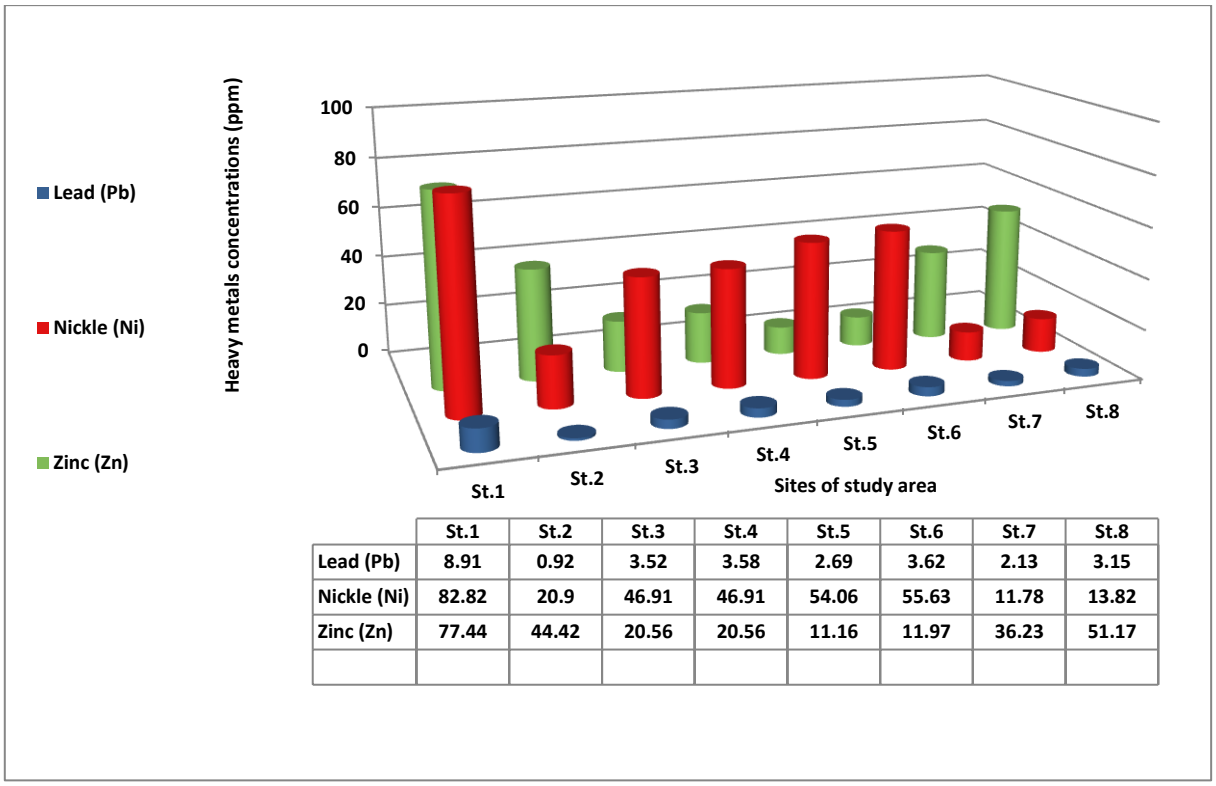


	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8
Iron (Fe)	21042.54	19734.59	19321.93	20441.03	20465.51	17249.85	16905.37	22259.56

Figure 4- Iron (Fe) concentration (ppm) in soil of agricultural area

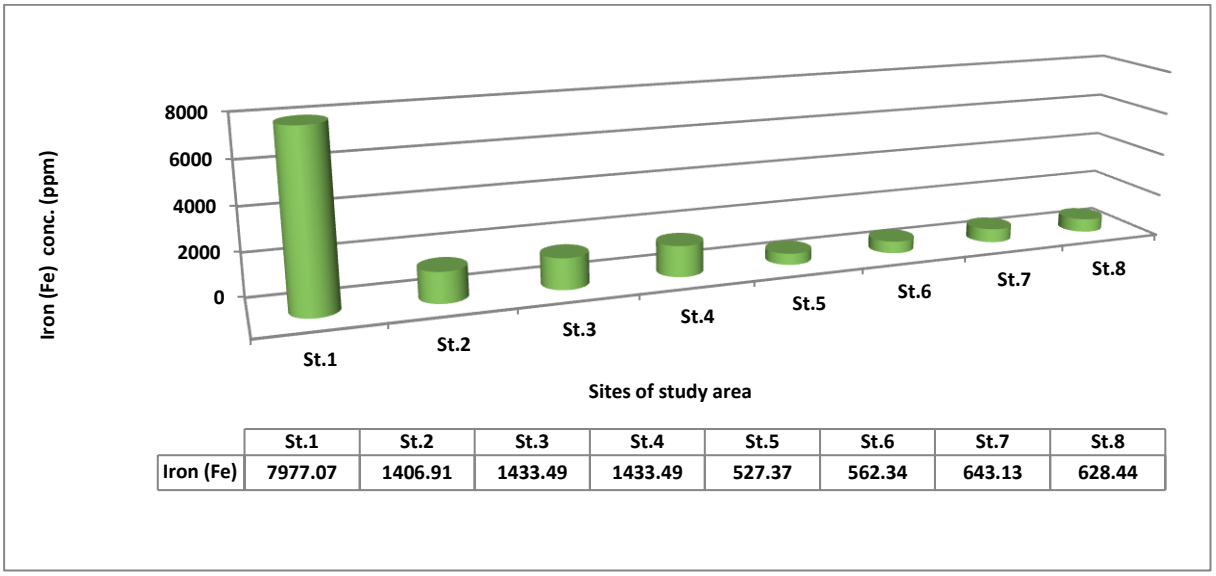
The readings of Pb, Ni, Zn, and Fe in vegetable crops samples were 0.92-8.91, 11.78-82.82, 11.16-77.44 and 527.37-7977.07 ppm (Figures 5, 6), respectively.

In vegetable crops samples for all sites the results of Pb, Ni and Fe are above the standard limits of WHO [8, 11, 2], with an exception in Site. 2 of Pb content which is within WHO limits, whereas Zn content is within the permissible limits of WHO, except in site 1, site.8 the Zn content is above the WHO standards, may be this return to the uptake by plants, physiological state for plants.



	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8
Lead (Pb)	8.91	0.92	3.52	3.58	2.69	3.62	2.13	3.15
Nickle (Ni)	82.82	20.9	46.91	46.91	54.06	55.63	11.78	13.82
Zinc (Zn)	77.44	44.42	20.56	20.56	11.16	11.97	36.23	51.17

Figure 5- Heavy metals concentrations (ppm) in vegetable crops



	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8
Iron (Fe)	7977.07	1406.91	1433.49	1433.49	527.37	562.34	643.13	628.44

Figure 6- Iron (Fe) concentrations (ppm) in vegetable crops

Conclusion

- This research conclude that wells water is slightly acidic, rich with ions according to EC and TDS results (according to Fipps [15] classification.
- The soil is saline sodic according to physical chemical parameters [15].
- In water samples, all values of heavy metals under study are above the acceptable limits of WHO, except for Zn value which is within the WHO levels.
- Soil samples content of Ni and Zn are within allowable limits of WHO, while Pb and Fe is higher than WHO levels.
- In vegetable crops samples, at all sites the results of Pb, Ni and Fe are above the standard limits of WHO, with an exception in Site. 2 of Pb content which is within WHO limits, whereas Zn

content is within the permissible limits of WHO, except in site 1, site.8 the Zn content is above the WHO standards.

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