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## Study of Changes in Soil Bacteria and Some Heavy Metals in Different Soil Depths in Soil Irrigated with Wastewater.

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**ABSTRACT**

A soil irrigated with wastewater for many years was chosen to collect samples from different soil depths (0-15,16-30, 31-45) cm. Changes of soil bacteria and some heavy metals were determined with different soil depths. Results showed that total bacteria count of surface soil (0-15) cm was higher in soil irrigated with waste water (4.9 $\times10^6$cfug$^{-1}$soil) while it was (1.5$\times10^6$cfug$^{-1}$ soil ) in soil irrigated with river water. Total coliforms ranged from(1.21$\times10^2$cfug$^{-1}$soil) in surface soil with waste water irrigation and( 0.75$\times10^2$ cfug$^{-1}$soil) with river water irrigation. While fecal coliforms were found only in the surface soil irrigated with waste water. The concentration of heavy metals, was affected by continues application of waste water irrigation. These heavy metals decreased with depth due to low mobility in soil. Accumulation of heavy metals occurred in (0-15, 16-30) cm depths. Concentrations of Cd, Pb and Ni in vegetable Crops grown in soil irrigated with wastewater were high. Maximum accumulations of these heavy metals were in Potato, which is considered as a good accumulator of heavy metals.

**Keywords**: Potato, coliform, soil, wastewater, heavy metals.

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## INTRODUCTION

Soil microbiological community is ecologically and dynamically important, diverse, cycling of element and being ultimate receptor of wastes in many arid and semi- arid zone countries, where wastewater and other source was used as irrigation[1,2].Because of limited reuse of water increased population, and the increased environment, health and safe disposal of wastewater [3,4]. Waste water is a large amount of water is considered as an available source of irrigation and agricultural use. Wastewater may contain wide spectrum of pathogens, heavy metals and organic compounds that are hazardous to the soil environment [5]. Heavy metals in soil are athreat of human and animal health [6]. Heavy metals have an inhibitory effect on the growth of bacteria, fungi and actinomycetes [7]. Heavy metals have an important role in biological life, there for high concentration might be a great effect to human health and biological life [8]. In Asian countries there is a decline in fresh water availability for agricultural farms. Wastewater and chemical fertilizer are the main source of heavy metals contamination in the environment [9, 10]. These heavy metals may accumulate to a toxic concentrations level, which can be athreat of human life [11] The wastewater influence on agricultural soil for many years is becoming a major source of heavy metals contamination in soil and ground water [12].

The aim of this study is to establish the effect of soil irrigated with waste water on its environment.

## MATERIAL AND METHODS

### Soil samples:

Samples were collected from an area irrigated with wastewater in south of Baghdad city. Soil samples were taken at the following depths (0-15, 16-30, 31-45) cm using Auger hole sampling method, soil samples were divided into two parts. The first one parwas stored at4C for Microbiological studies, the other part was air- dry and sieved to pass through a 2-mm sieve for chemical and physical analysis.

### Soil and water Analysis:

Soil samples were analysed for soil pH and EC in (1:1) soil: water suspension and $CaC0_3$ was determined by Calcimeter, soil organic Carbon [13], cation exchange capacity (CEC) [14]. DTPA- TEA-$CaCl_2$extractable (Cd, Pb and Ni) was analysed by using Atomic absorption[ 15]. Soil texture was determined by hydrometer method[16].Wastewater samples were analysed for EC, pH, BOD and heavy metals (Cd, Pb and Ni).

### Microbiological Analysis:

Serial soil dilutions were prepared by weighting: 10 gm soil and dispersing for 20minttes.in 90 ml of sterile water in triplicates of dilutions( $10^{-4}$,$10^{-5}$,$10^{-6}$),then 0.5ml was transferred in to PGY agar (peptone, glucose, yeast extract Agar)plates [17].Plats were incubated at 30C for 72hours and total aerobic micro-flora was counted (cfu $g^{-1}$soil). According to the multiple tube fermentation tests, total coliforms were counted using Lauryltryptosebroth tubes(presumptive test) where tubes were inoculated at serial soil dilution($10^{-4}$ – $10^{-5}$ and$10^{-6}$) for each soil sample. Tubes were incubated at 37C for 48 hours and the most probable number(MPN)was calculated for soil samples. The fecal Coliforms were treated on fecal Coliforms Ec broth, then incubated at40$^o$C for 24 hours.

### Plant analysis:

Two plants species including the root group with three replications namely( Potato and Cauliflower).Plants were washed with tap water then distilled water, 0.01 HCl solution, air dried and oven at 70C then mixed to make them homogeneous for chemical analysis. Samples were digested in mixture of$H_2SO_4$:$HClO_4$(4:2)and heated over hot plate till fumes stopped. Then dissolved in volumetric flask with distilled water to 50 ml and Cd, Pb and Ni were determined using Atomic absorption Spectrophotometer.

## RESULTS AND DISCUSSION

**Soil Analysis:**

The soil highly calcareous, electrical conductivity (EC) was moderate, Cation exchange capacity (CEC) was relatively high, soil texture was silty Clay loam in all locations. Table (1).

**Table 1: General characteristic of soil irrigated at wastewater.**

| Depth Cm | pH | EC $dsm^{-1}$ | CEC $Cmolkg^{-1}$ | $CaCO_3$ % | O.M % | Clay % | Silt % | Sand % |
|---|---|---|---|---|---|---|---|---|
| **0 – 15** | 7.20 | 3.10 | 28.10 | 32.02 | 1.28 | 29.71 | 53.21 | 17.08 |
| **16– 30** | 7.15 | 2.85 | 28.25 | 31.80 | 1.37 | 34.22 | 54.01 | 11.77 |
| **31– 45** | 7.12 | 2.54 | 28.29 | 31.12 | 1.45 | 38.11 | 55.25 | 6.64 |

Results showed that (EC) of soil increased with irrigation with waste water, while it decreased with depth due to slow downward movement of ions. The organic carbon content decreased with increasing depth and accumulation of organic carbon occurred in top soil (0 – 15) cm because of the higher concentration of organic matter content in wastewater irrigated soil.

**Total Bacteria Counts:**

Results showed the distribution and count of aerobic bacteria in soil samples irrigated with wastewater for many years. Counts of bacteria in soil surface(0 – 15)cm were higher compared to other soil depths counts were($4.9\times10^6$cfu $g^{-1}$soil) in soil surface(0 – 15)cm and $2.1\times10^6$cfu$g^{-1}$soil in soil depth(16 – 30)cm and ($1.1\times10^6$cfu $g^{-1}$soil) in soil depth (31 – 45) cm in soil irrigated with wastewater, while soil irrigated with river water counts ranged from $1.5\times10^6$cfu$g^{-1}$soil to $0.6\times10^6$cfu$g^{-1}$soil. Table (2).

**Table 2: Distribution of aerobic bacteria counts (cfu$g^{-1}$soil $\times10^6$) in soil irrigated at wastewater and river water**

| Soil depth (Cm) | Count bacteria ( Wastewater) | Count bacteria (River water) |
|---|---|---|
| **0 – 15** | 4.9 $\times10^6$ | 1.5 $\times10^6$ |
| **16– 30** | 2.1 $\times10^6$ | 1.2 $\times10^6$ |
| **31- 45** | 1.1 $\times10^6$ | 0.6 $\times10^6$ |

This bacteria are more resistance to water pollution, and it can benefit from the addition of nutrients, microbes and organic materials present in wastewater. The type of water used for irrigation affected the differences in microbial counts. The counts of total aerobic bacteria of surface soil were similar in all sites irrigated with and without wastewater suggesting that the use of did not inhibit these microfloras [18].

**Total Coliforms and Fecal coliforms:**

The total counts of coliform in soil irrigated with wastewater were ($2.9\times10^3$cfu$g^{-1}$soil)at soil surface (0 – 15)cm and the counts tended to be higher than at soil depth (16 – 30)cm and in soil depth (31 – 45)cm which counts were( $0.1\times10^3$cfu g-1soil). Fecal coliform counts found in irrigated sites with wastewater higher counts in soil surface (0 – 15) cm than at other soil depth and non detectable counts were observed at soil depth ( 31 – 45) cm. Table( 3).

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**Table 3: total coliform, fecal coliform counts (cfug$^{-1}$soil×10$^{2}$) in soil irrigated at wastewater and river water**

| Soil depth Cm | Total coliform Wastewater | Total coliform River water | Fecal coliform Wastewater | Fecal coliform River water |
|---|---|---|---|---|
| **0 – 15** | 1.21 | 0.75 | 0.82 | 0.23 |
| **16– 30** | 0.17 | 0.10 | 0.31 | 0.10 |
| **31– 45** | —— | —— | —— | —— |

Reference [19] and other researchers reported that the use of fecal coliforms as an indicator of pollution is a better indicator of pollution than total coliform since they may include strains that are not of fecal origin.

**Table 4: Results of wastewater samples analysis:**

| Parameter | Unit | TW | T. R.w | parameter | unit | Tw | T. R.w |
|---|---|---|---|---|---|---|---|
| **pH** | | 7.30 | 7.10 | Cd | mg kg$^{-1}$ | 0.018 | 0.002 |
| **EC** | dsm$^{-1}$ | 2.83 | 1.55 | Pb | mg kg$^{-1}$ | 0.890 | 0.057 |
| **BOD** | mg kg$^{-1}$ | 24.21 | 0.07 | Ni | mg kg$^{-1}$ | 0.979 | 0.071 |

**Concentrations of extractable heavy metals:**

Results showed that extractable Cd, Pb and Ni in soil irrigated with wastewater was higher than soil irrigated with river water ,because of accumulation of heavy metal presented in wastewater. Concentration of heavy metals decreased with depth (table 5) which my be due to lower vertical movement, and the immobilization of heavy metals occurse by adsorption and accumulation on the surface of oxides and hydroxides in soil. Organic carbon and clay content influenced the availability of ( Cd, Pb and Ni) in soil. The concentration of extractable heavy metals at various soil depths irrigated with wastewater ranged at( 1.125 - o.765)mgCdkg$^{-1}$, (16.920 – 6.452) mgPbkg$^{-1}$ and (24.300 – 10. 339) mgNi kg$^{-1}$. Similar results are also reported by [20].

**Table 5: mean values of extractable (Cd, Pb and Ni) mgkg-1in soil irrigated with wastewater and river water.**

| Soil depth Cm | Cd | | | Pb | | | Ni | | |
|---|---|---|---|---|---|---|---|---|---|
| | soil Tw | soil TR.w | Mean | Soil Tw | Soil TR.w | Mean | Soil Tw | Soil TR.w | Mean |
| **0 – 15** | 1.125 | 0.133 | 0.629 | 16.629 | 2.955 | 9.937 | 24.300 | 2.811 | 13.555 |
| **16 – 30** | 0.935 | 0.110 | 0.522 | 12.421 | 1.158 | 6.789 | 17.352 | 1.730 | 9.541 |
| **31 – 45** | 0.763 | 0.095 | 0.430 | 6.452 | 0.897 | 3.674 | 10.331 | 1.159 | 5.745 |
| **Mean** | 0.941 | 0.112 | 0.527 | 11.931 | 1.670 | 6.800 | 17.327 | 1.900 | 9.613 |

Tw : soil irrigated with wastewater. TR.w: soil irrigated with river water

Results showed that the concentrations of Cd, Pb and Ni in crops grown in soil Irrigated with wastewater were from 0.100 to 5.162 mgCdkg$^{-1}$, from 1.450 to 25.240mgPbkg$^{-1}$ and from 0.880 to 18.661mg Nikg$^{-1}$. Potato crop has a maximum accumulation of these heavy metals. Table( 6).

**Table 6: concentrations of (Cd, Pb and Ni) mgkg$^{-1}$ in crops grown in soil irrigated by wastewater and river water.**

| vegetable crop | Cd | | | Pb | | | Ni | | |
|---|---|---|---|---|---|---|---|---|---|
| | Soil Tw | Soil TR.w | mean | Soil Tw | Soil TR.w | mean | Soil Tw | Soil TR.w | mean |
| **Potato** | 5.162 | 0.475 | 2.818 | 25.240 | 2.585 | 13.912 | 18.661 | 1.221 | 9.941 |
| **Cauliflower** | 1.381 | 0.100 | 0.740 | 21.262 | 1.450 | 11.356 | 10.250 | 0.880 | 5.569 |
| **Mean** | 3.271 | 0.287 | 1.779 | 23.251 | 2.017 | 12.634 | 14.455 | 1.050 | 7.755 |

## CONCLUSION

This study found that the organic materials and the bacteria presented in wastewater that used for irrigated agricultural land is higher in surfacesoil. The changes in soil bacteria counts and the availability of some heavy metals In soil due to the continuous surface application of waste water. Coliforms and fecal coliforms were detected in surface soil irrigated with waste water. The concentrations of some heavy metals in this study increased in soil and crops grown in soil irrigated with waste water. Maximum accumulation of heavy metals was in Potato crop.

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