ISSN: 0067-2904

Mercury Levels in Soil, Leafy Plants and Irrigation Well Water at Several Agricultural Fields in Baghdad Government, Iraq

Shaimaa Salim Abd Ali*, Mahmood Basil Mahmood
Department of Biology, College of Science, University of Baghdad, Baghdad, Iraq

Abstract

Soil and plant contamination with heavy metals is one of the current problems in the world especially contamination with mercury. Heavy metals are very harmful because of their long biological half-lives, non-biodegradable nature and their possibility to accumulate at different body parts. Soil, well water and leafy plant samples (*Apium graveoleus, Allium ampeloprasum, Lepidium sativum, Eruca sativa, Petroselinum hortense, Ocimum basilicum , Mentha pulegium*) from three different agricultural fields (AL-Musafer village (site 1), AL-Autaifiyah (site 2) and AL-Huriyah (site 3)) in Baghdad government, Iraq were analyzed for mercury concentration. Hg level in soil samples ranged from 3.67 to 5.33 ppm in AL-Autaifiyah and AL-Musafer village, respectively. While, in water samples Hg level ranged from 1.2 in AL-Autaifiyah to 22.8 mg/l in AL-Musafer village. Plant samples recorded Hg level ranged from 0.009 to 2.88 ppm in AL-Autaifiyah and AL-Huriyah, respectively. The results showed that Hg level in water samples and most plant samples were above the acceptable limit according to WHO (1993), and FAQ/WHO (1999) respectively. While Hg level in soil samples was within the acceptable limit put by Ministry of the Environment, Finland (2007).

Keywords: metals, mercury, well water, agriculture fields.

مستويات الزئبق في الترب و النباتات الورقية و مياه الابار المستخدمة للارواء في عدة اراضي زراعية في محافظة بغداد, العراق

شيماء سالم عبد علي* ، محمود باسل محمود
قسم علوم الحياة ، كلية العلوم ، جامعة بغداد، بغداد ، العراق

الخلاصة

تلوث التربة والنباتات بالمعادن الثقيلة هي احد المشاكل الحالية في العالم وخاصة التلوث بالزئبق. خطورة المعادن الثقيلة تكمن بسبب طول نصف العمر, طبيعتها الغير القابلة للتحلل الحيوي و قدرتها للتجمع في مختلف اجزاء الجسم. تم جمع عينات التربة ومياه الابار والنباتات الورقية (كرفس , كراث , رشاد , جرجير , بقدونس , ريحان و نعناع) من ثلاثة اراضي زراعية مختلفة (قرية المسافر (الموقع الاول), العطيفية (الموقع الثاني) و الحرية (الموقع الثالث)) في محافظة بغداد , العراق لتقدير تركيز الزئبق فيها. تركيز الزئبق في عينات التربة تراوحت بين 3.67 الى 5.33 جزء بالمليون في العطيفية وقرية المسافر على التوالي. في حين ان مستويات الزئبق في عينات الماء تراوحت بين 1.2 جزء بالمليون في العطيفية الى 22.8 جزء بالمليون في قرية المسافر. اما في عينات النباتات فتراوحت تراكيز الزئبق بين 0.009 الى 2.88 جزء بالمليون في العطيفية والحرية على التوالي. النتائج بينت ان مستوى الزئبق في عينات الماء ومعظم عينات النباتات هو

*Email: Shaimaasalem64@yahoo.com

اعلى من الحد المسموح به وفقا لمنظمة الصحة العالمية (1993) ومنظمة الاغذية والزراعة / ومنظمة الصحة العالمية (1999). بينما مستويات الزئبق في عينات التربة كانت ضمن الحد المسموح بيه وفقا لوزارة البيئة , فنلندا (2007).

Introduction

Heavy metals occur naturally in the environment from weathering processes of parent materials and also through anthropogenic sources. The most significant natural sources are weathering of minerals, erosion and volcanic activity, while the anthropogenic sources depend on human activities such as smelting, mining, electroplating, phosphate fertilizer discharge and use of pesticides, bio solids (composts, livestock manures and municipal sewage sludge), atmospheric deposition, *etc.* [1,2]These heavy metals can be leached into surface water or groundwater, taken by plants, released as gasses into the atmosphere or bonded with soil components such as clay or organic matter [3]. Heavy metals are an important contaminant because of their toxicity and difficult degradation [4]. The heavy metals and metalloids, including arsenic (As), manganese (Mn), lead (Pb), cadmium (Cd), and mercury (Hg), are possible bio hazardous, have strong toxicity at even low concentrations, can accumulate in body tissues over long periods of time, and are nonessential for human health [5].

Mercury (Hg) considered a main hazardous material by the Agency for Toxic Substances and Disease Registry (ATSDR) because of its persistence, bioaccumulation and neurotoxicity to human being [6, 7]. Due to anthropogenic activities like smelting, mining, application of fertilizer, sewage sludge, and Hg containing fungicides to soils, the annual import of toxic mercury into the agricultural lands and other ecosystems has become a serious concern [8]. The large mercury input into the arable lands has resulted in the diffused occurrence of mercury-contamination in the whole food chain [9]. The elevated mercury concentration in ecology is a potential threat to human health [10]. Mercury causes many disease and damage such as autoimmune diseases, depression, fatigue, drowsiness, hair loss, insomnia, loss of memory, restlessness, disturbance of vision, tremors, temper outbursts, brain damage, lung and kidney failure [11, 12, 13]. This research aims to investigate mercury concentrations in soil, irrigation wells water and leafy plants in some agriculture fields in Baghdad Government.

Materials and methods

Study area and Sampling

The current study was designed to examine soil, well water and leafy plants taken from different three agricultural fields (AL-Musafer village (site 1), AL-Autaifiyah (site 2) and AL-Huriyah (site 3)) in Baghdad Government during the study period from October 2016 to June 2017. Fields location: AL-Musafer village located in south of Baghdad city (N 33°10.533', E 044°20.750').AL-Autaifiyah region located in the center of Baghdad city (N 33°20.961', E 044°21.916').AL-Huriyah region located in west of Baghdad city (N 33°20.548', E 044°19.416'), Figures-1 and 2.

Figure 1-study area AL-Autaifiyah and AL-Huriyah

Figure2-Study area AL-Musafer region village.

The soil samples and leafy plants were collected in sterile polyethylene bags for heavy metal analyses [14]. While water samples were collected in plastic bottles of 1L were used for heavy metal tests [14].

Heavy metal 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 analyzed by DMA-80 technical which directly analysis the mercury in soil, the technique is safety, productivity, sensitive, flexible, cost-effective, accuracy of the result and performance [15]. Plants samples (*Apium graveoleus* (site 1, 3), *Allium ampeloprasum* (site 1,3), *Lepidium sativum* (site 1), *Eruca sativa* (site 2), *Petroselinum Hortense* (site. 2), *Ocimum basilicum* (site 2,3), *Mentha pulegium* (site 2)) which collected by plastic bags from the agriculture fields were air dried and oven dried at 50°C, then smashed by mortar and sieved with 212 µm sieve to get fine powder, the analyzed done by using DMA-80 technique (Direct Mercury Analyzer) [15]. Water samples analysis done by using Flameless Atomic Absorption Spectrometry (253.7 nm).

Results and discussion

Soil Mercury level

The highest mean value was 5.33 ppm which recorded in site 1 during summer, while the lowest mean value was 3.67 ppm in site 2 during autumn. Results recorded were within the acceptable limit set in the Finnish legislation for contaminated soil [16] which it is 2-5 ppm except for the highest value (Figure-3). Many factors had affected Hg level in soil include soil pH, organic matter, sewage irrigation, atmospheric deposition, pesticides and fertilizer applications and other human activities [17]. Results of current study agreed with [18], while it disagreed with [19] in which they recorded values lower than this study.

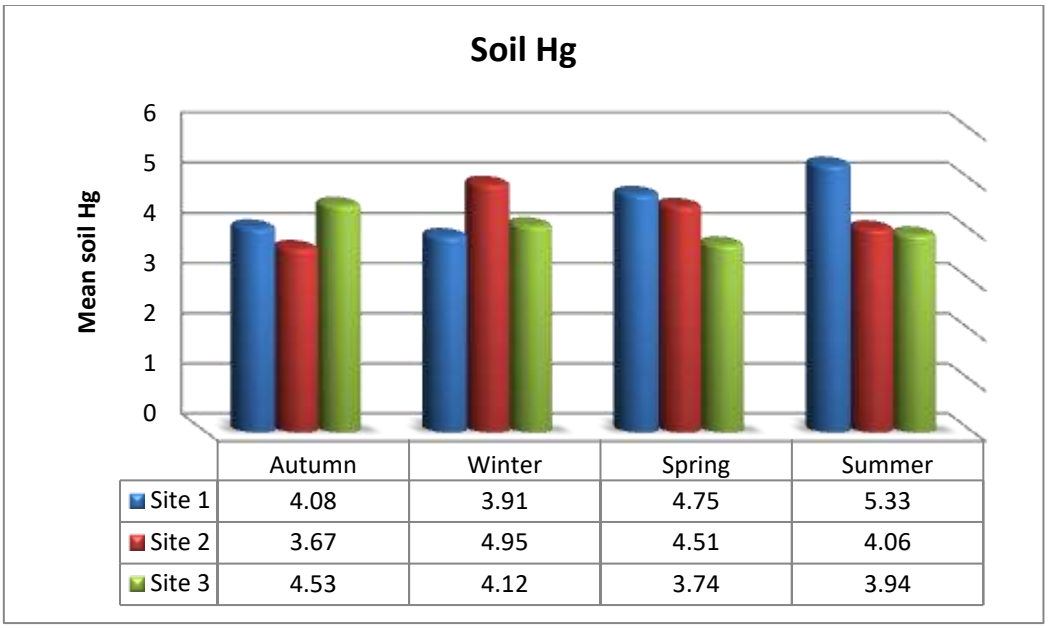

Figure 3-Seasonal means of soil Hg values (ppm) for the studied sites

Water Mercury level

In the case of water Hg level the acceptable limit is 0.001 mg/l according to WHO [20], all values in current study were above the acceptable limit. Solid waste incineration such as municipal and medical wastes is one of the anthropogenic emission sources of mercury [21, 22], also urban discharges and agricultural activities are sources for mercury. Mercury from combustion sources usually enters the atmosphere, and then some of it set down in nearby water or land. The highest level showed in site 1 and 2 (Figure-4). However, there was a riverbed near site 1 so may be discharges on it is the source of mercury in site 1. Site 2 is near Tigris River and a local hospital so it's probably the main source of mercury in that site. The current study agreed with [23].

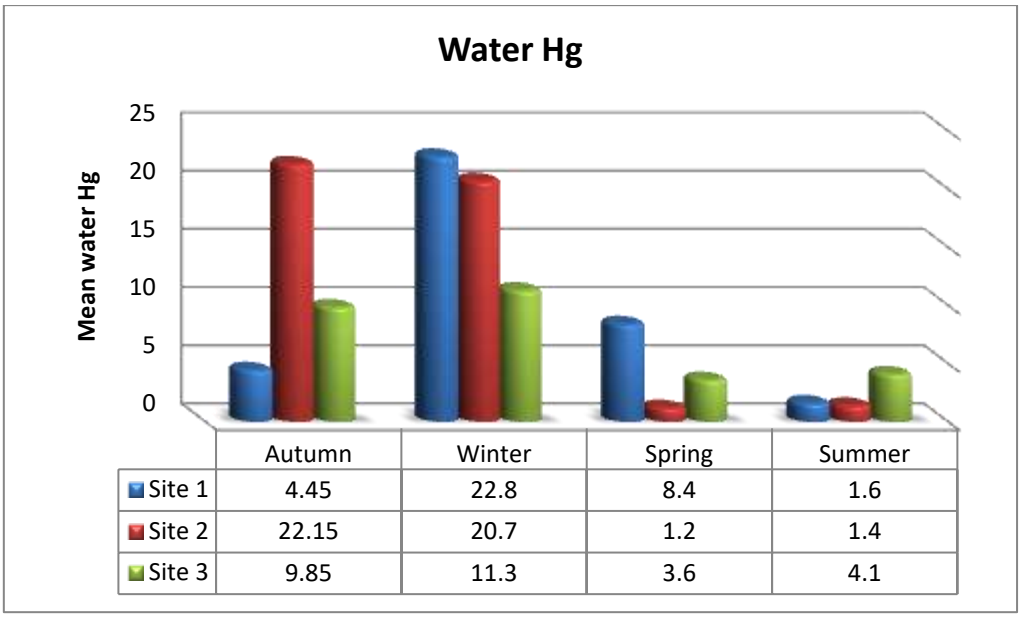

Figure 4-Seasonal means of water Hg values (mg/l) for the studied sites.

Plants mercury levels

Mean values which recorded in the current study showed differences between sites and seasons especially during summer season which recorded the highest mean values in both site 2 and 3 (1.783 and 2.88 ppm, respectively). However, the lowest mean value was recorded in site 2 during winter which it was 0.009 ppm (Figure-5).

The values in site 1 and 3 in current study were above the permissible limiting of mercury in food and food stuff according to FAO/WHO (1999) [24], which its 0.03 ppm, while in site 2 the values recorded were within the limit except in summer season in which it was above the permissible limit. The high value of Hg in summer may be due to the high temperature as results showed that in higher temperature recorded higher concentration of mercury in leaves and whole plants, that's probably related to evaporation of elemental mercury from soils [25]. So, the elemental Hg which released to the atmosphere may be absorbed again by both surface soil and plants [26].

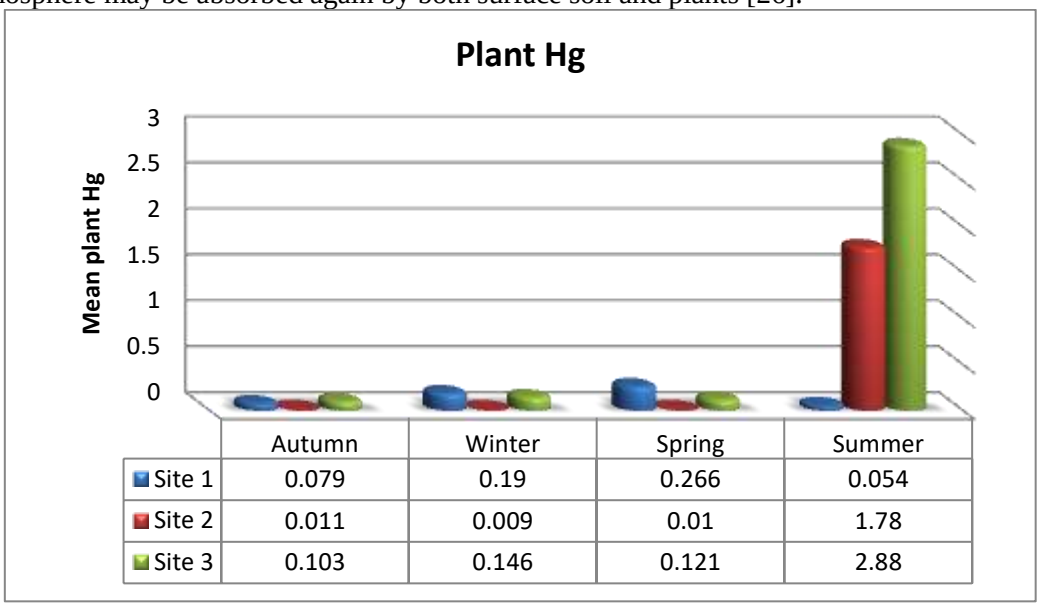

Figure 5-Seasonal means of plant Hg values (ppm) for the studied sites.

In addition, the high contents of mercury accumulate in the leafy plants in this study may resulted from the high values of mercury in the well water that used for irrigation in the studied fields. Mercury

is toxic in human when taken in excessive concentrations [27]; it leads to progressive irreversible brain damage [28].

Current study mean values disagreed with [29] because they recorded fluctuation results, some of them were within the acceptable limit and others were above the acceptable limits. Also, its disagreed with [30], this disagreement may be due to the different study area, agricultural practice and level of pollution.

Conclusion

According to results in the current study, soil samples were not contaminated with mercury (Hg), well water samples in this study were contaminated with Hg and most leafy plants samples in the studied sites recorded mercury levels above the permissible level of WHO [20] and FAO/WHO [24].

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