Perennial Existence of Organochlorine Pesticides in the Soils of Amghara, Kuwait

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Research Article

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Abstract

A comprehensive study from the surface soil samples of 14 locations from Amghara, Kuwait were assessed for the investigation organochlorine pesticides (OCPs). Due the high degree of contamination in the environment and the health consequences of OCPs, the assessment of these compounds had a significant concern. There is limited informations regarding the distribution pattern of OCPs in the soil samples of Kuwait. The study comprises 12 OCPs including their isomers. Pesticide residue analysis was done with a gas chromatograph for organochlorine pesticides (OCPs) coupled to a triple quadruple mass spectrometer in electron ionization mode. The total concentration of OCPs were in the range of 209.39 pg/g -7449.18 pg/g with an average value of 1313.04 pg/g. DDT had higher concentrations in soil samples (969.52 pg/g) than the other pesticides, according to the findings. The distribution pattern of OCPs in the Amghara soils revealed their origin as both historical and recent application of pesticides. The impact of soil pH on the distribution of DDTs in Amghara soil samples were also investigated. The study further looked at how residual quantities could be used to determine health risks of both children and adults. Children and adults in all the locations were subject to negligible cancer risk, according to the health risk evaluation. OCP's cancer dangers from ingestion, dermal exposure, and inhalation of soil particles indicated that all stations were in the safe zone.

Highlights

- Assessment of OCPs along the Amghara soil has done.
- Cancer risk was lower for OCPs.
- DDTs were the dominant OCPs among the 12 OCPs and its isomers.
- Observed level of DDT was due to the old practice.

Introduction

Organochlorine pesticides (OCPs), which are semi-volatile and stable synthetic chemicals, enter the environment by numerous matrices and bioaccumulate in food chains as they pass through different biological trophic layers (Keithmaleesatti et al.2007;Wang et al.2015). OCPs are used as chemicals for controlling and eliminating the insects, weeds, fungi, and bacteria (Jayaraj et al, 2016). Last few decades the widespread use of OCPs were observed. Furthermore, these chemicals were extensively used to deter vector-borne epidemic diseases in tropical countries. Due to the high level of environmental toxicity and health impacts, the large-scale production and use of OCPs (HCHs and DDTs) is currently prohibited. However, the environmental, human and wildlife health impacts of their residues have been detected and reported in many countries (Kumar et al, 2011; Anderson et al, 2014; Sun et al, 2016; Kafaei et al, 2020; Alshemmari et al, 2021a). HCHs and DDTs are often used as representative compounds in assessing the environmental status of OCPs due to their wide variety of historical uses, human health, and environmental impacts (Zhao et al, 2009). POPs are particularly obstinate to chemical and biological degradation and thus live for long periods in the environment (Alshemmari et al, 2021b) In order to treat

the persistent organic pollutants (POPs) in an excellent way the Stockholm Convention has listed variety classes of POPs based on their toxicity. The majority of the initially listed 12 POPs were pesticides including aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, HCB, mirex, and toxaphene (Alshemmari et al, 2021c). In the past decade, more POPs pesticides were newly listed in the Convention including chlordecone, dicofol, alpha-/beta-HCH, lindane (gamma-HCH), PCP and sulfluramide (a PFOS related substance). Almost all POPs pesticides are listed in Annex A of the SC and need to be eliminated with a few granted specific exemptions for endosulfan, lindane, and PCP. Most of POPs pesticides have been substituted in the past 20 years by other pesticides. Often, the alternative pesticides used were not sufficiently assessed and frequently, other highly hazardous pesticides (HHPs) have been introduced or systemic pesticides with an impact on pollinators and the ecosystem (Rahman et al, 2012; Van der Sluijs et al, 2015). Despite the fact that pesticides were phased out decades ago, large concentrations of accumulated pesticides in agricultural soils have become significant re-emission contributors to the environment (Tao et al., 2008).

Soil was a repository for all kinds of contaminants, including OCP inputs. Many OCPs have a strong preference for dirt, which could be absorbed by crops and grazing animals and thereby enter humans. They may also have been washed into watercourses through run-off from the soil and discharged into the atmosphere by volatilization, resulting in water and atmospheric pollution (Fu et al., 2003; Bidleman and Leone, 2004). Agriculture is the largest consumer of pesticides, accounting for 14 percent of global agricultural land and requiring widespread pesticide use (Atapattu and Kodituwakku, 2009). According to Behera and Singh (1999), weeds can reduce crop yield by 37–79 percent, which can be managed with herbicides. Domestic, commercial, and agricultural sources all emit OCPs into the environment. Until deposition on soils and water, OCPs can fly a long way in the wind (Leadprathom et al., 2009). As a result, they will be detected hundreds or thousands of miles away from their application sites. Some OCPs are volatile, while others can cling to soils or airborne particles (Smaranda and Gavrilescu, 2008). Because of their bioaccumulation capacity and toxicities in mammals, they pose a significant danger to human health and the environment. Neurological trauma, cancer, endocrine system dysfunction, immune system suppression, and death have all been linked to OCPs (Xiaofei et al., 2008; Kumar et al., 2011). OCP contaminations can originate from both point and non-point sources, and they can be transported to the far locations through air circulation and oceanic currents (Bentzen et al., 2008). Industrial effluent and household waste discharges, atmospheric deposition, drainage, and leaching from agricultural field land/soil, and disposal all mobilize OCPs into water sources and soil (Yang et al., 2005).

Pesticide intake and human health data over the last two decades have shown that some pesticides cause neurological disorders and degenerative diseases, that some affect fetal development and cause congenital defects, and that some are carcinogenic to humans (Asghar et al. 2016). In many developed nations, the indiscriminate usage and unsafe treatment of pesticides in cultivation has resulted in severe public health issues over the last three decades (Dasgupta et al. 2007). Pesticides have been linked to a variety of negative health effects, which vary in severity and length of exposure. Pesticides have a wide variety of health effects, from minor asthma, rashes, respiratory problems, neurotoxicity, and reproductive disorders to lethal chronic diseases such as cancer. Preventive methods, such as the use of alternative

sustainable farming approaches, or mitigation strategies, such as reducing pesticide emissions from food and water by various production processes, can be used to overcome this food safety problem (Tomer et al. 2015).

Pesticides are a source of fear around the world because of the possible dangers they pose to human health (Doong et al. 2002; Darko and Acquaah 2007). The evaluation and control of OCPs in vegetable crops provides a foundation for assessing the risk of these toxins to human health (Qu et al, 2015). Pesticide residues in soils and vegetables from different areas around the world have been assessed in previous studies (Chourasiya et al. 2015; Fosu-Mensah et al. 2016; Yadav et al. 2016; Barron et al. 2017; Fang et al. 2017; Mahugija et al. 2017). Pesticide use in agriculture is causing increasing public health concerns in other parts of the world (Samsel and Seneff, 2013; Shelton et al, 2014; Bhandari et al, 2020). Previous studies considered the ecological risk assessment of soil OCP pollution (Gao et al., 2013; Jiang et al., 2009; Yu et al., 2013), but less attention was paid to the health risk associated with soil OCP exposure, especially in agricultural soils that serve as reservoirs for agrochemical OCPs. Gevao et al., 2018 reported on previous studies of organochlorine pesticides in Kuwait, with the emphasis on air samples from urban, rural, and industrial areas. Along the urban, remote, and industrial areas, the concentrations were 33-1352 pg/m3, 4.5–556 pg/m3, and 8.8–533 pg/m3, respectively. Several studies focused on OCPs in agricultural soil have been published. Southern Iran (Kafaei et al, 2020), Northern China (Pan et al, 2019), Argentina (Lupi et al, 2019), Europe (Silva et al, 2019), Southern Italy (Qu et al, 2019), Pakistan (Ali et al, 2019), Kuttanad, India (Sruthi et al, 2016), etc. The recent study reported in the agricultural region of Sulaibiya shows the average concentration of OCPs (organochlorine pesticides) was 3062 pg/g (Alshemmari et al, 2021). The present study discussed the distribution pattern of OCPs along the Amghara locations situated in Kuwait. The study has also discussed the health risk assessment due to the use of OCPs along the observed locations.

Materials And Methods

Sampling

The location of the sampling at the Amghara is shown in the **Figure** 1. The region is about 20 kilometers north of Kuwait City and 1.5 kilometers from the Gulf coast. The sites are in close proximity to commercial centers. Amghara is Kuwait's oldest and biggest recycling center. It houses a historic scrap metal plant that can accept and handle all forms of metal scrap, including end-of-life cars (Alshemmari, 2021b). Millions of tons of processed and recycled scrap metal have gone through the system over the years. It also houses Kuwait's first plastic recycling facility, which has helped divert hundreds of thousands of tons of plastic scrap from landfill sites in Kuwait. Using a pre-cleaned stainless steel scoop, four subsamples were gathered inside a 50 m 50 m plot at each position and thoroughly combined to create a homogeneous composite sample. All samples were wrapped in aluminum foil, covered in polythene containers, and stored at -4 °C until ready to be analyzed.

Extraction and Analysis

The US-EPA suggested 8080A method was used for OCP study of soil samples (Chen et al., 2011, Yang et al., 2013, Zhang et al., 2013). Prior to Soxhlet-dichloromethane (DCM) extraction, portions of 10 g air-dried soils were spiked with 20 ng mixed recovery surrogates containing 2, 4, 5, 6-tetrachloro-m-xylene (TCmX) and decachlorobiphenyl (PCB209) for 24 hours. Enabled copper granules were added to the sample flask to remove elemental sulphur. The OCP extracts were first dissolved in hexane and the final amount was reduced to 2-3 mL by rotary evaporation. To purify the concentrate, the OCPs were eluted with 30 mL DCM/hexane (2/3, v/v) on an alumina/silica (v/v = 1:2) gel column (48 h DCM extraction, then 180 °C and 240 °C 12 h muffle drying, all 3 percent H2O deactivated). The eluent was condensed to 0.2 mL using a gentle nitrogen current. The samples were then moved to 100-l glass inserts and spiked with 20 ng isodrin before being analyzed using an Agilent 7890B gas chromatograph for organochlorine pesticides (OCPs) coupled to a triple quadruple mass spectrometer in electron ionisation mode.

On a 30-m DB5-ms column (0.25 mm i.d., 0.25-m film thickness, J&W Scientific), the analytes were separated using helium as a carrier gas. The furnace unit was set to 70°C for 2 minutes, then ramped at 25°C min-1 to 150°C, 3°C min-1 to 200°C, and 8°C min-1 to 280°C for 10 minutes. The injector temperature was set to 280°C, the ion source was set to 300°C, the quadrupole was set to 150°C, and the transfer thread was set to 310°C. The carrier gas was helium at a flow rate of 2.6 ml/min, and the collision gas was nitrogen at a flow rate of 1.5 ml/min. The gas chromatograph was equipped with a back flush capability. At the end of each run, a 5-minute back flush was performed while the oven temperature was maintained at 310 °C. Multiple reaction monitoring (MRM) with two transitions per analyte was used to detect and confirm analytes using the triple quadrupole in MS/MS mode. For data processing, Mass-Hunter analysis software was used.

To assess total organic carbon (TOC), 3 g of freeze-dried soil was treated for 24 hours with 1mol/L HCl to remove all inorganic carbon. The soil was then dried at 85 °C overnight until it reached a steady weight. TOC was determined using traditional routine techniques on portions of 50 mg treated soil. GRADISTAT version 2.0 was used to determine grain size. The program was developed for the grain size statistics given by mm. The graphical approach was used to quantify the physical representation of the sediment.

Quality assurance/ Quality control

Stringent quality-assurance and quality-control protocols were implemented to monitor the analytical process. Identification and quantification were done using 5 calibration levels of known concentrations. A peak was positively established if it was within 0.05 minutes of the calibration standard's retention period, and only quantified if the S/N was 3 and the ratio of the ion to its qualifier ion was within 20% of the standard value. There was no discernible difference between laboratory and field blanks, implying negligible contamination during transport, storage, and examination. When analytes were found in a batch of samples in a blank, the values were subtracted from those found in the sample extracts. The method detection limits (MDLs) were calculated using the mean of the field blank +3 × SD. In situations where the target analytes were not found in the field blanks, the given MDL value was calculated as three

times the signal-to-noise ratio of the lowest calibration. Surrogate recovery was found to be 85 ± 12% for the majority of pesticides studied.

Carcinogenic risk assessment

Cancer hazards from ingestion, dermal route, and inhalation of soil particles were calculated using the following Eqs. (1), (2), and (3), which were modified from two US Environmental Protection Agency reports (U.S. EPA) (USEPA, 1997, 2009) (Qu et al, 2017).

$$CRingest = \frac{Csoil \times IngR \times EF \times ED}{BW \times AT} \times CF \times SFsoil \quad (1)$$

In Eq. (1), CRingest is the cancer risk associated with unintended soil absorption, Csoil is the contaminant content of soil (mg kg1), IngR is the ingestion rate of soil (mg d1), EF is the exposure level (days year1), ED is the exposure period (a), BW is the average body weight (kg), AT is the averaging time (d), and CF is the conversion factor (1 × 10−6 kg mg−1), and SForal is the oral slope factor (2.0E + 00 (mg kg−1 d−1)−1).

$$CRdermal = \frac{Csoil \times SA \times AFsoil \times ABS \times EF \times ED}{BW \times AT} \times CF \times SFsoil \times GIABS \quad (2)$$

In Eq. (2), CRdermal is the cancer risk via dermal contact of soil, SA is the surface region of the skin that touches the soil (cm2), AF soil is the soil adherence factor (mg cm2), and ABS is the dermal absorption factor (chemical specific). The percentage of contaminants ingested in the gastrointestinal tract is known as GIABS.

$$CRinhale = \frac{Csoil \times SA \times InhR \times AFinh \times EF \times ED}{PEF \times AT} \times IUR \quad (3)$$

In Eq. (3), CRinhale is the cancer risk via inhalation of soil, InhR is the inhalation rate ($m^3\ d^{-1}$), AFInh is the absorption factor for the lungs, PEF is the particle emission factor ($1.36 \times 10^9\ m^3\ kg^{-1}$), and IUR is the inhalation unit risk (5.7E−01 $(mg\ m^3)^{-1}$), which equals to the slope factor via inhalation. Inhalation of toxins adsorbed to inhalable particles is treated by the PEF (PM 10). The risk of cancer from ingestion, dermal contact, and inhalation was calculated using a 70-year human lifespan. In this situation, an adult soil ingestion rate (IngR) of 100 mg d1 was used. Exposure duration (ED) of 70 years was used based on the average lifespan, and an assumed exposure frequency (EF) of 350 days/year, excluding 15 days of holidays, was adopted. An upper-bound value of averaging time (AT) was calculated as 70 × 365 = 25,550 days. The skin interaction surface area with soil was set at 3300 cm2, assuming that hands and

arms were exposed to soil, and a body weight of 70 kg was chosen. AF soil had a density of 0.2 mg/cm2. Adults inhaled at a rate of 15.8 m3 d1. For a provisional risk estimate, the GIABS and AF Inh values were set to 1. ABS is chemically unique, with a value of 0.13 (Ge et al. 2013).

Results And Discussions

3.1. Distribution pattern of OCPs

The present study discusses the level of OCPs and health risk assessment of these OCPs along the 14 locations of the Amghara. There are few studies have done about the OCPs in the soil samples of Kuwait. The level of DDT is dominating compared to the level of other OCPs from the surveyed locations. Pentachlorobenzene was observed only at one location (Station C), the concentration was 19.42 pg/g. The range of Σ_{22}OCP along the Amghara locations were ND to 7449.19 pg/g. The distribution pattern of BHC is shown in the **Figure** 2. The level of BHC were observed at only 5 locations (A, B, C, E, and F). The rest all the observed locations were in the below detection range of BHC. The least observed form of BHC was delta among the all 4 forms of BHC. Apart from that delta form of BHC was observed only at one location (A) and the correspondent concentration was 10.93 pg/g. Each form of OCP had a different distribution pattern in Amghara, implying that different groups of OCPs were not used at the same time in this region. In comparison to the amount of DDTs in this sample, all types of BHC have moderately low concentrations. The α/ -ratio is used to differentiate fresh BHC inputs based on the composition of BHCs (Alshemmari et al, 2021). A high ratio of α/ -BHC thus represents historical evidence of BHCs, while a low ratio of α/ -BHC indicates recent use of BHC (Tao et al., 2005). The present study showed the α/ -BHC ratios of 0.79-0.89 indicates the recent use of these BHC. However, the use of these pesticides are legally stopped in Kuwait, it might be originated from the obsolete stocks. The ratio of - HCH/HCH is less than 0.5, indicating recent HCH inputs (Aamir et al, 2018, Wang et al, 2016). According to the current research, the ratio was in the range of 0.34 to 0.42. It alludes to BHC's recent activities. In all the stations relatively higher proportion of β-BHC was observed. Both α and -BHCs are commonly transformed to β -BHC in the soil matrix (Willett et al. 1998), which may be one of the reasons for the high prevalence of β -BHC in Amghara soils. The results also suggest that β -BHC's (relatively persistent form) predominance may be attributable to its recent use. β - BHC has a higher tolerance for soil organic matter and a lower rate of evaporation. Furthermore, as opposed to other types of BHCs, the organization of chlorine atoms in the molecular structure of β -BHC prevents microbial degradation. (Sruthy et al, 2017). The proliferation of β-HCH is due to its lower degradation, water solubility, and good affinity for soil adsorption (Onogbosele et al, 2014, Sánchez-Palencia et al, 2017), as well as microorganisms and photoisomerization conversion of γ-HCH isomer to β-HCH (Onogbosele et al, 2014, Sánchez-Palencia et al (Zhang et al, 2003).

Hexachlorobenzene was ubiquitous along the observed locations and the concentration was in the range of ND-1297.64 pg/g. Chlordane-oxy was observed only at two locations with an average value of 40.56 pg/g. Chlordane-cis and trans were in the range of ND-36.56 pg/g and ND-50 pg/g respectively (**Figure** 3). Heptachlor was in the range of ND-40.56 pg/g. The level of nonachlor-cis and trans were shown in the **Figure** 4 and it was in the range of ND-11.33 and ND-23.22 respectively. Aldrin and dieldrin were detected

with an average value of 52.43 pg/g and 38.67 pg/g respectively. The higher average value of Aldrin is due to the elevated level of Aldrin at the location B. The rest all the stations the level of Aldrin is quite low. Aldrin has the affinity for the swift conversion in to Dieldrin (Akhil and Sujatha, 2014). The present data of Aldrin and dieldrin follows the quick conversion rate of Aldrin to dieldrin. The level of endosulfan was comparatively lower with respect to the previously reported values from the soil of Kuwait (Alshemmari et al, 2021). The present study showed, endosulfan has an average value of 58.67 pg/g. While comparing the values of endosulfan reported in the other part of the world like India, the concentration was very low. Endosulfan residues in various (isomeric) types have been found in agricultural soils in southern India (Sunitha et al. 2011). According to GFEA-U (2007), the half-lives of α, β, and total endosulfan in soil under aerobic conditions will range from 12–39, 108–264, and 288–2241 days, respectively. Endosulfan and its residue can cause a variety of deformities in humans, including brain injury, autism, cerebral palsy, cancer, and more. β -endosulfan is less soluble in soil than β-endosulfan, and it has more harmful effects on organisms than α-endosulfan (Lu et al. 2000). The graphical representation of all the OCPs shown in the current study is shown in the **Figure** 5.

The presence of DDT in the bulk of the soil samples tested attests to the compound's long-term stability in the environment (Lewis et al. 2016). The most predominant OCPs observed in the present study was DDTs. The distribution pattern of DDTs along the observed locations is shown in the **Figure** 6. All the locations, except the location D, the significant level of DDTs were observed. The level of DDE-o, p' and DDE-p, p' were in the range of ND-68.15 pg/g and ND-5094.71 pg/g respectively. The reported level of DDD-o, p' and DDD-p, p' were in the range of ND-99.8 pg/g and ND-203.33 pg/g. The concentration of DDT-o, p'and DDT-p, p' were in the range of ND-181.03 pg/g and ND-1444.39 pg/g respectively. The 'p, p'-DDT/ (p, p'-DDE + p, p'-DDD)' ratio can also serve as a signal of the degradation degree of p, p'-DDT in the soil or present soil contamination to this isomer. If the ratio is less than 1, the old practice of DDT can be concluded. If this ratio is greater than 1, it indicates that the environment has recently been affected by DDT. The present study shows the degradation degree in the range of 0.17-0.99. This data reveals that, observed level of DDT was due to the old practice. DDD and DDE may have formed as a result of DDT dehydrochlorination caused by biotic or abiotic decomposition reactions (Sruthy et al, 2017). The value is smaller than residual levels at Dalki and Shabankare in Iran (Kafaei et al, 2020), Mexico (Sanchez-Osorio et al, 2017), Wuhan, China (Zhou et al, 2013), Southern farms in the United States (Bidleman and Leone, 2004), Palakkad in India (Gopalan and Chenicherry, 2018), and Sulaibiya in Kuwait (Alshemmari et al, 2021). Half-life period of DDT in the soil has been reported as 8–20 years (Andreu and Pico 2004, Dimond and Owen 2013). The longer half-life period of DDT might be a reason for the prevalence dominance of DDT compared to the other OCPs observed in the current study. The metabolic ratio studies in the present work is agreeing with the previous studies reported in the nearby region (Alshemmari et al, 2021) and in the other part of the World (Aamir et al, 2018, Wang et al, 2016, Zhang et al, 2018, Sruthy et al, 2017). The comparative distribution pattern of OCPs around the world and the present study is shown in the **Table** 1.

3.2. Variations of DDT with soil pH

In order to interrelate the possibility of effect of soil pH on the distribution of DDTs along the observed soil samples of Amghara were tested. The assumption was made based on the knowledge that certain microorganisms that can degrade DDT have better degradation capabilities at neutral and alkaline pH (Wang et al. 2010, Pan et al. 2016), even though the structure of the soil microbiota can affect DDT degradation potential both directly (Regar et al. 2019, Gaur et al. 2018) and indirectly (e.g., by the activity of microbial enzymes) (Xu et al. 2019). The distribution of pH along the observed locations is shown in the **Table** 2. The correlation pattern shows a moderate negative correlation with a correlation coefficient of -0.43. Even though a possible explanation of this result could derive from the limited number of samples assessed, it is known that several other environmental factors (i.e., soil texture, application history, climatic conditions, etc.) can affect the persistence or degradation of DDT residues (Boul et al. 1994, Spencer et al. 1996, Zhao et al. 2010), thus modifying their bioavailability. The differences between the sampled fields in relation to these factors could thus account for the limited correlation found. To understand the behavior of DDT residues, more research is needed on the complex interactions between soil physical–chemical properties, its microbiome, including microbial functional degradation ability, and the crops' physiological contribution to the soil environment in relation to the possibilities to degrade DDT (Sun et al. 2015), especially under climate change conditions. (Gaur et al. 2018). Despite the fact that seasonal variance in DDT concentrations has been recorded in soils (Zhang et al. 2013), which is consistent with the observation of differential residue release into the atmosphere (Motelay-Massei et al. 2005, Liu et al. 2009), sampling regularly at the end of summer during our testing exercise could have minimized the likelihood of a bias in the findings due to seasonal variations.

3.3. Health risk assessment

It is significant that to perform health risk assessment studies based on the OCPs in the collected soil samples. The cancer risk assessment for both children and adult were assessed based on the ingestion, inhale and dermal routes. The cancer risk assessment of both adult and children along the observed Amghara location is shown in the **Figure** 7. The observed results shows a higher risk to children than adults. The same trend has reported in various studies (Alshemmari et al, 2021, Qu et al, 2017). Values below 1×10^{-6} (one case per million exposed people) is considered as negligible risk of cancer (Kafaei et al, 2020). The present study showed a cancer risk assessment value of 1.53×10^{-10}- 150×10^{-10} (Adult) and 1.99×10^{-10}- 197.24×10^{-10} (Children). The current study's cancer risk appraisal scores is below the mark, indicating that cancer is not a significant danger to people who are exposed to polluted soil. Our findings are consistent with those of other research (Ge et al, 2013, Qu et al, 2017), which found no evidence of cancer risk from various routes of exposure due to low levels of pesticides in soil. The comparative cancer risk assessment trials in specific areas around the world as seen in **Table** 3.Throughout the present report, the average incidence of cancer in children was higher than in adults in every stations. Many of the imbalance can be attributed to the ingestion and dermal routes, since children are more likely to be exposed to soil as a result of their play (Qu et al., 2017). Ingestion > dermal > inhalation was the pattern of rising risk, which was also observed in OCP-polluted soils in Xiangfen County, China (Ma et al., 2016). Inhalation of OCPs containing soil particles has a carcinogenic effect

that is 10^4-10^5 times smaller than ingestion and dermal interaction with soil-containing OCPs, so inhalation of OCP particles is insignificant for all three exposure pathways. Despite the fact that the current research found no evidence of a cancer risk associated with soil, extra precautions must be taken to avoid possible exposure to several toxins in different routes. The presence of these potential OCPs in the soil may pose a health risk to individuals.

Conclusions

The residual level of OCPs in the Amghara soil was estimated using the US-EPA suggested 8080A approach. The current study assessed the major groups of OCPs. The prevalence of β -BHC in Amghara soils might be due to the transformation of α and -BHCs med to β -BHC in the soil matrix. Moreover, the proliferation of β-HCH was observed due to its lower degradation, water solubility, and good affinity for soil adsorption. The longer half-life period of DDT might be a reason for the prevalence dominance of DDT compared to the other OCPs observed in the current study. The correlation pattern of DDT with pH shows a moderate negative correlation with a correlation coefficient of -0.43. This result could derive from the limited number of samples assessed, it is known that several other environmental factors (i.e., soil texture, application history, climatic conditions, etc.) can affect the persistence or degradation of DDT residues. The cancer risk assessment levels in this sample are below average, meaning that cancer is not a significant threat to people exposed to contaminated soil. About the fact that the current study showed no signs of a connection between soil and cancer, extra measures must be taken to prevent potential exposure to several contaminants via various routes. Individuals may be exposed to these possible OCPs in the soil, posing a health risk.

Declarations

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Conflict of Interest

The current paper doesn’t have any conflict of interest. The corresponding author approves the above statement as well.

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Tables

Table 1. The comparative study of OCPs around the world

Location	∑OCPs (ng/g)	Reference
Souther farms, USA (9compounds)	220.79	Bidleman and Leone, 2004
Wuhan, China (14 compounds)	169.8	Zhou et al, 2013
Mexico (14 compounds)	50.59	Sanchez-Osorio et al, 2017
Catchment area, Pakistan (15 compounds)	3.48	Bajwa et al, 2016
Kenya	7.74	Sun et al, 2016
Palkkad, India (5 compounds)	23.36	Gopalan and Chenicherry, 2018
Shabankare, Iran (14 compounds)	15.05	Kafaei et al, 2020
Dalki, Iran (14 compounds)	6.83	Kafaei et al, 2020
Riyad, Saudi Arabia	557	Albedair and Alturiqi,2020
Sulaibia, Kuwait	3.06	Alshemmari et al, 2021
Amghara, Kuwait	1.26	Present study

Table 2. The distribution of pH along the observed locations

Locations	pH
A	8.24
B	8.1
C	8.21
D	7.96
E	8.06
F	8.06
G	7.95
H	8.24
I	8.06
J	8.14
K	8.29
L	8.28
M	8.29
N	8.16

Table 3. The comparative studies of cancer risk assessment along the particular locations around the World

Cancer Risk Assessment Study			
Locations	Children	Adult	References
Korba, India	4×10^{-7}	7.8×10^{-9}	Kumar et al, 2014
Southeast China	4.91×10^{-4}	5.07×10^{-4}	Qu et al, 2015
China	No data	10^{-11} to 10^{-6}	Li et al, 2018
Shabankare, Iran	10.93×10^{-9}	7.98×10^{-9}	Kafaei et al, 2020
Sulaibiya, Kuwait	8.08×10^{-10} to 359.02×10^{-10}	6.173×10^{-10} to 274.3×10^{-10}	Alshemmari et al, 2021
Amghara, Kuwait	1.99×10^{-10} to 197.24×10^{-10}	1.53×10^{-10} to 150×10^{-10}	Present study

Figures

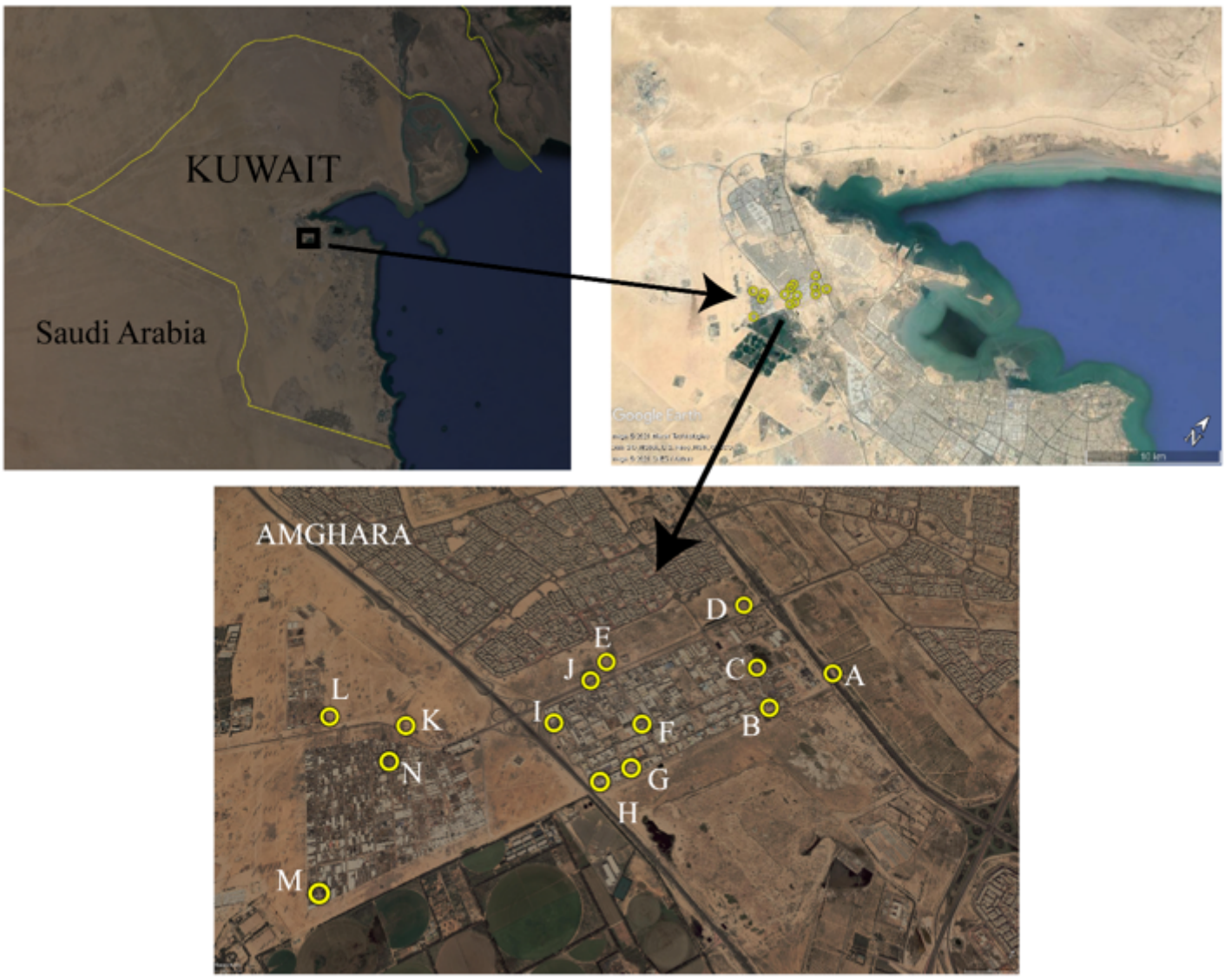


Figure 1

The sampling locations at the Amghara, Kuwait Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

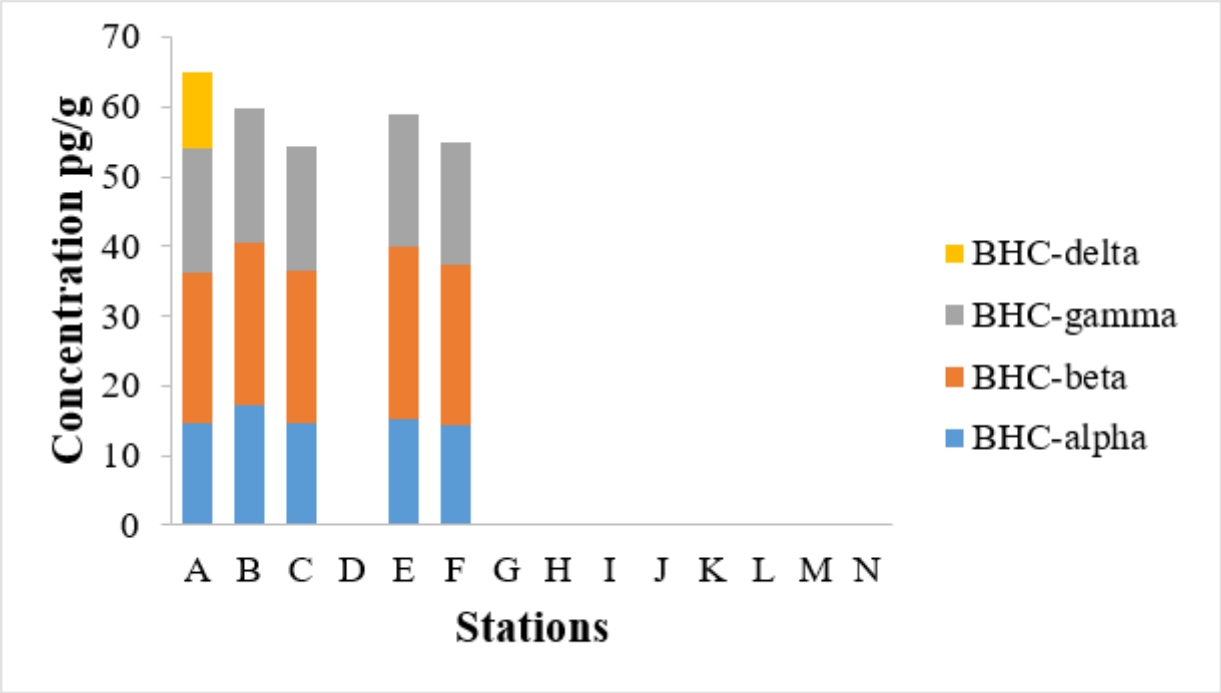


Figure 2

The distribution pattern of BHC along the observed Amghara locations.

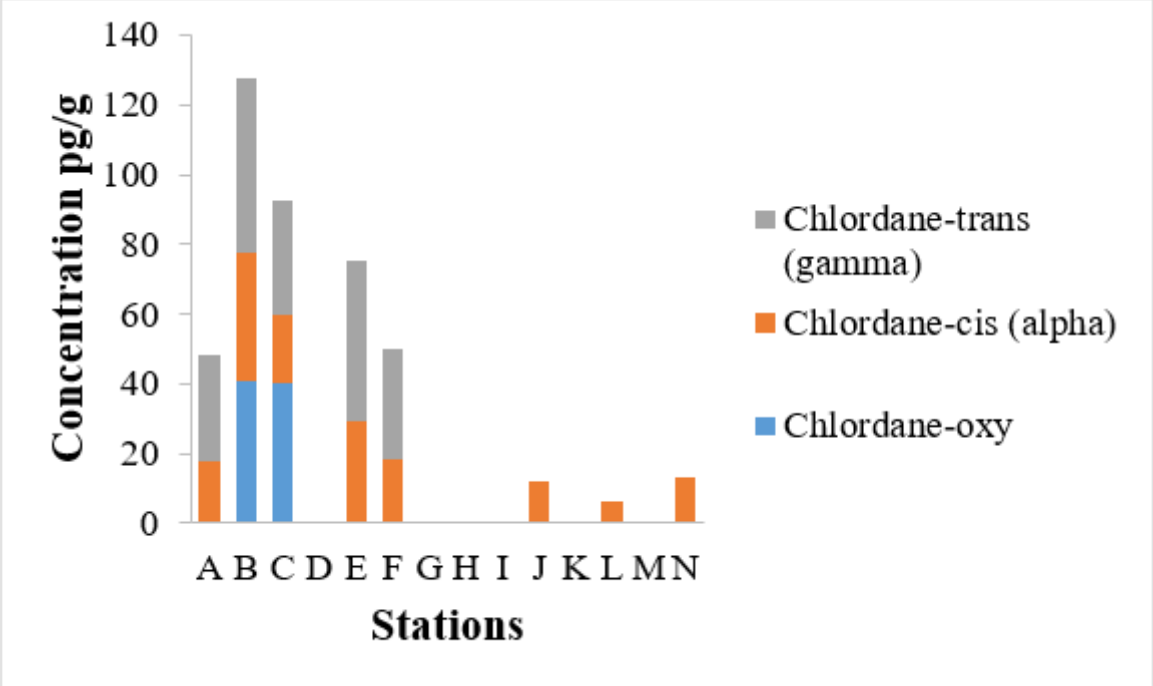


Figure 3

The distribution pattern of Chlordane isomers along the observed Amghara locations.

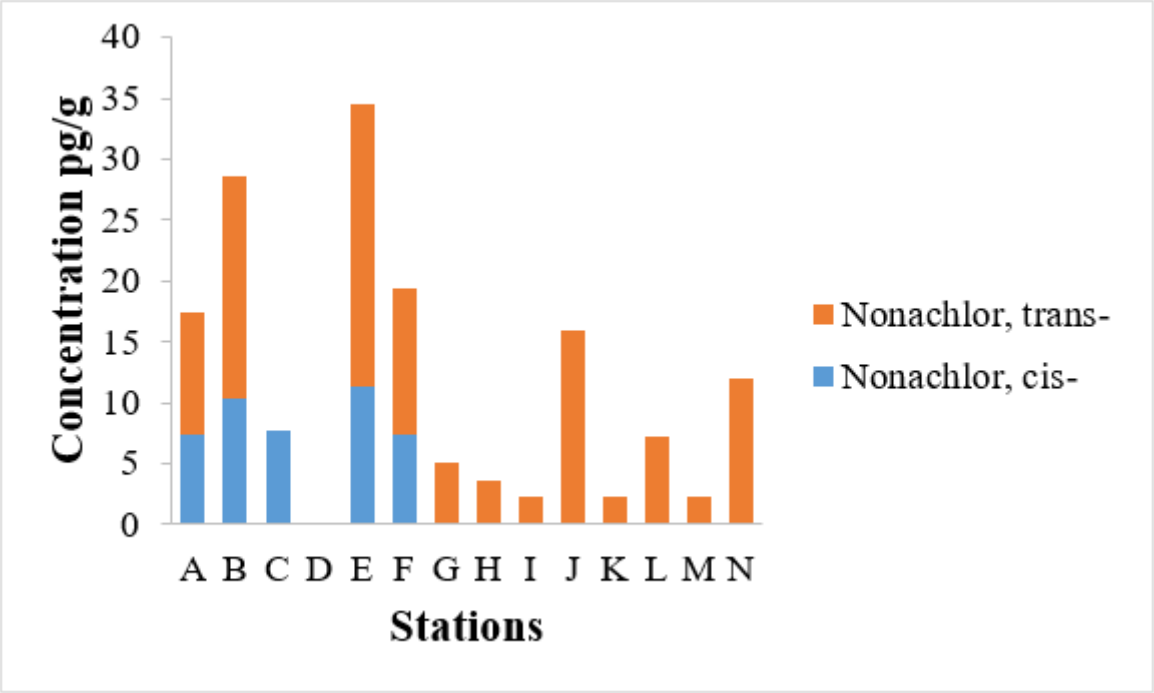


Figure 4

The distribution pattern of Nonachlors isomers along the observed Amghara locations.

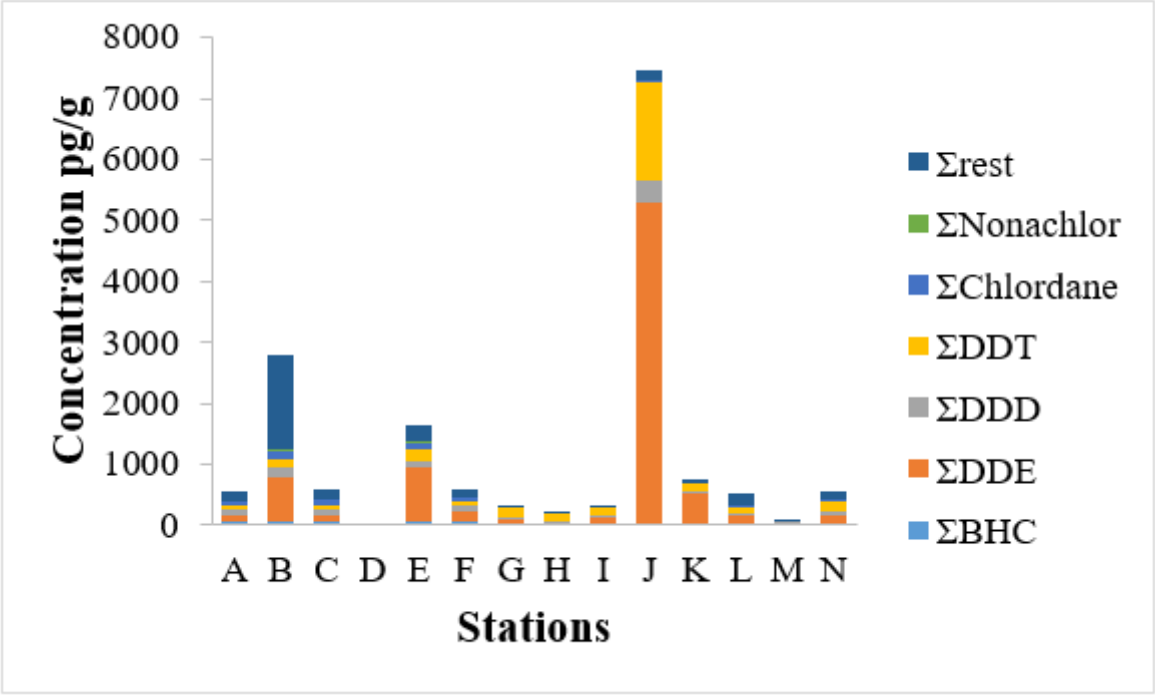


Figure 5

The distribution pattern of all the targeted OCPs along the observed Amghara locations.

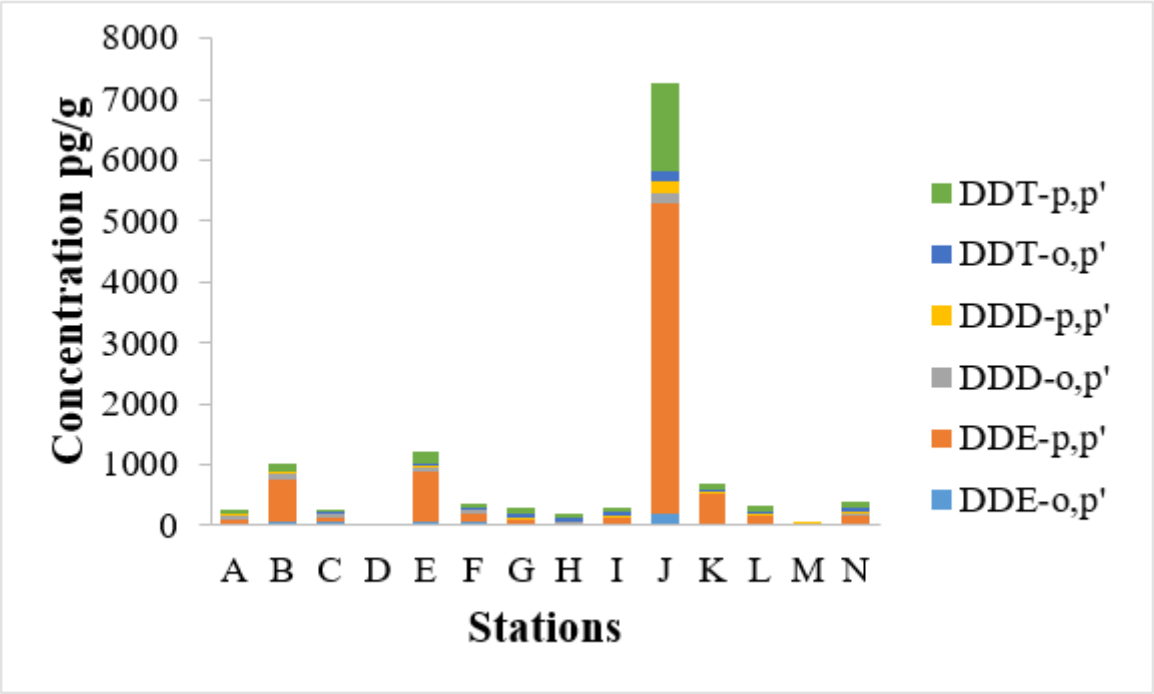
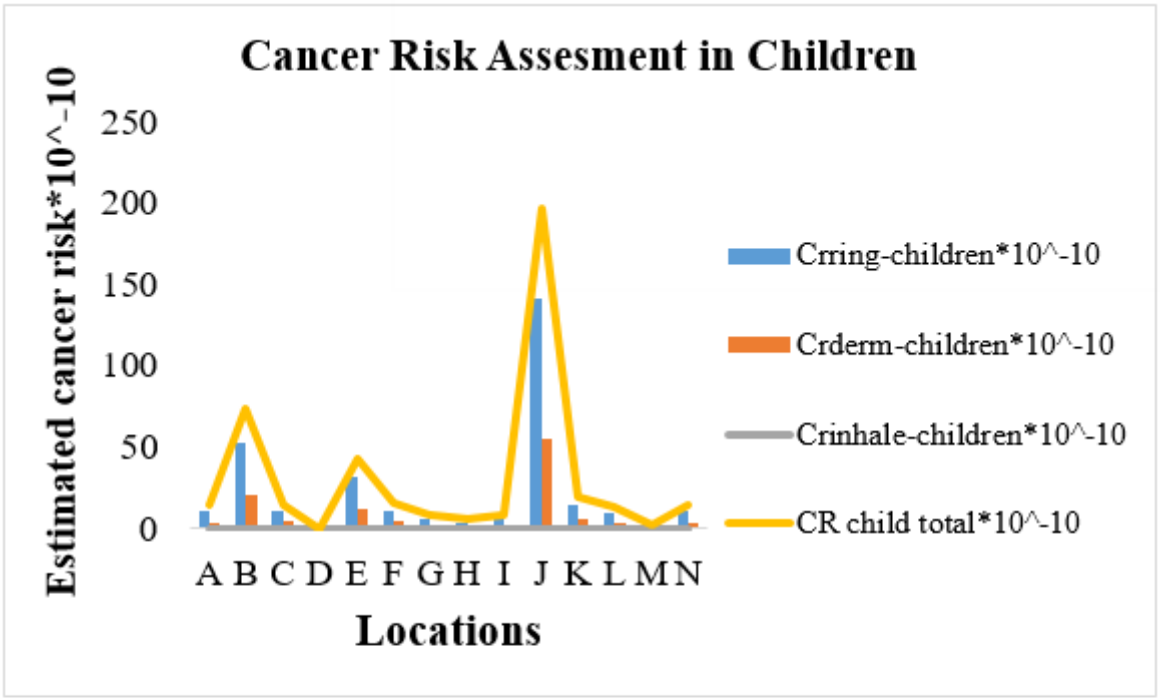


Figure 6

The distribution pattern of DDTs along the observed Amghara locations.



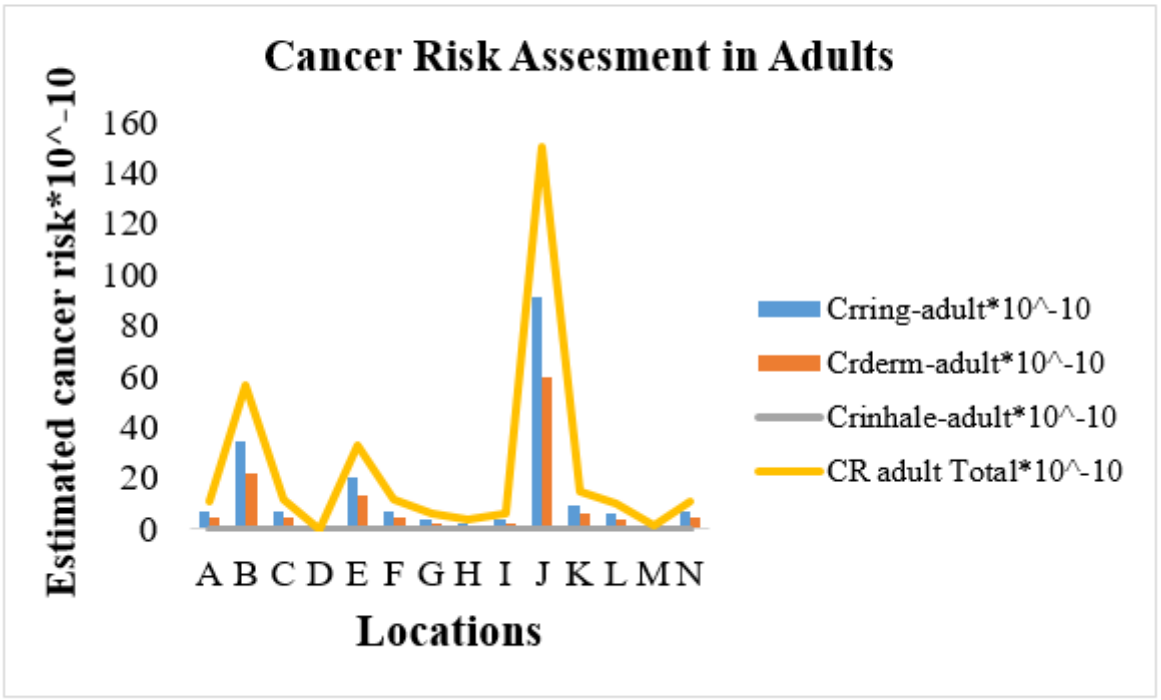


Figure 7

Estimated cancer risk through various route for children and adults along the observed locations.