Original Article

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A Study on the Effect of Ultraviolet Light on Malathion in Water

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Abstract

Organophosphates are the most common pesticides being utilized all over the world. These compounds are toxic which can easily penetrate the water table and other drinking sources during application in crop fields. Since using some drinking water accumulating an amount of toxins of raised value than the standard level, causes unwanted effects on health of human beings. This experiment aimed to investigate the effectiveness of removal of Malathion from water by technique of ultraviolet irradiation (UV) medium pressure and with a Mercury lamp.

Methods: In this investigation, variants of initial pH and primary concentrations and exposure times were observed. Initial concentrations of Malathion were 0.5, 1 and 2 mg/l. The samples aliquots were then exposed to UV irradiation irregularly with the time periods of 10, 20, 30, 40, 50 and 60 minutes. The UV average pressure (irradiation intensity = 200 W/m2) lamp were applied in the reactor to conclude the quantity of Malathion prior and after the irradiation by HPLC instrument. In addition, the results obtained from the research were analysed using SPSS software and ANOVA and t-test statistical trials.

Results: The least concentration dropped off took place at 10 min (46%) and the highestdecrease in 60 min (87.25%) ($P<0.05$)furthermore, the effectiveness of irradiation procedure is inversely proportional to the concentration of pesticide ($P< 0.001$). Nonetheless, the efficiency of the methodrises with increase in pH.

Conclusion: The result data exhibits the most efficacies were achieved at pH= 9, at 60 min and 0.5 mg/l subsequently the application of UV reactors could be considered as asuitable method.

Keywords: Pesticide; Malathion; Water, Ultraviolet Irradiation.

Introduction

Background: Organophosphorus pesticides are the most important and diverse category of easily available pesticides and almost 45% of insecticide comes in this group in the world. From farming lands the pests soaks toxins and go through the water resources by straight washing down and irrigation from used land. As well, rainwater on unexposed toxin spots percolates into the water sources. (Aggarwal, Borner 1994). In addition pesticides along water percolate into water table beneath the soil deposits and during water penetration. During rainy season some toxins can go through to air and as a result go into to sources of surface water and soil. Percolation of these contaminants materials in sources of supply water for drinking purpose can have undesirable results on population health and the environment (Videria et al. 2001, Safi 2002). Additionally residual of these pesticides are fatal for human health, action of Malathion is to one clean hereditary inhibiter

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operator in human that causes to unexposed the complications and problems in nervous system and create symptoms like dizziness, nausea and attention disorder (Videria et al. 2001, Fireston et al. 2005). This toxin has very vital effect on paediatric nervous system particularly in first years. So we must apply sure and proper ways for prevention of entrance these toxins to water source and air and land. (Alavanja et al. 2004, Rauh et al. 2006).

Now days some studies are being carried out regarding being and remains of these pollutants in surroundings. These investigations prove that post practice of pesticides in short times, their amount have been more than permissible limit (Shayeghi et al. 2001, 2004, 2007, 2010, Tarahi 2002, Honarpajoh et al. 2003, Hejazinejad et al. 2004, Khodadadi 2008, Shayeghi and Dehghani 2011). For example investigation performed by Shayeghi et al. (2007) on Malathion left behind in drinking water exhibited that residues of these toxins was present for some months in environment of that locality. Shayeghi et al. (2004) estimated remains of Malathion toxins in rivers water source and concluded that concentration of this poison has been more than tolerable extent in each river.

Different methods are there to eradicate organophosphate pesticides. Recently the modern technologies have been applied for removal or mitigation of pesticides poisons like irradiating of ultrasonic waves ultraviolet radiation and advanced oxidation technology (Samanidou and Fytianos 1988, Huston and Pignatello 1999, Hequet et al. 2001, Burrows et al. 2002, Walid et al. 2002, Badawy et al. 2006, Maldonado et al. 2006, Bavcon Kralj et al. 2007, Li An et al. 2011, Shayeghi and Dehghani 2011). As ultraviolet radiation is one of the operative and safe technologies that can be beneficial in management of surface and ground water sources which are contaminated by pesticides with its significant benefits. Certainly one of safety reasons and greeted this process is requirement that has present for purpose of recommend in laws observance and new rules of water management.

The helpfulness of this method as compared with other practice of water treatment is as follows

1. Adding of chemical substances is not needed, 2. Absorbent media not required 3. The reactor gets benefitted by better malleability, 4. The character of manufactured sewage is limpid and odourless and faultless 5. Almost all pesticides are degraded in the reactor considerably, 6. The fewer connection with pH inconsistency and water temperature in compared with other chemical materials, 7. To have safety and satisfactoriness from the viewpoint of refineries employees and the general people be proposed as a green technology.

A variety of experiments have been performed on removal of pesticides by ultraviolet radiation, like on effect of medium pressure lamp on Atrazine. The results were suggestive of ideal influence this way in Atrazine compound degradation. Bavcon Kralj et al. (2007) got result products of gotten mineral completely by photo-oxidation method by ultraviolet irradiation and visible light. Samanidou and Fytianos (1988) did analysis for estimations of photo-oxidation process conclusion on the carbamate. This research was performed by average pressure mercurial lamp. The outcomes were indicative of ideal influence ultraviolet irradiation in degradation of this object. Majorendeavour of this experiment were to review the efficiency of UV irradiation for degradation of Malathion pesticide from water and the outcome of irradiation time, primary concentration and pH changes impact on power of ultraviolet radiation efficiency in degradation of Malathion in water.

Materials and Methods

This research is the experimental-applicable study that performed In Institute for Industrial Research and Toxicology Ghaziabad U.P India. Malathion compound was prepared in the different concentrations and estimated. In this study, Malathion toxin has prepared and analyzed

The confrontation time to ultraviolet wave were selected on the basis of performed pre examinations in lab and also the measured concentrations in this research judging to performed studies about the present residual of Malathion Toxin in country upper layer of water (Shayeghi et al. 2001, 2004, 2007, 2010, 2011, Tarahi 2002, Honarpajoh et al. 2003, Hejazinejad et al. 2004, Khodadadi 2008).

The method of samples preparation

The extraction steps and samples preparation prepared for valuation were:

First, 500 ml of selected water sample is combined with separator funnel that has 1 L of capacity. In some cases from the Atman filter (0.45 µ m) used to pass the sample since it had cloudily suspended particles; then, 30 ml dichloromethane was treated with noted sample. For better separation two stages 15–20 g NaCl was added to contents of separator funnel; next, funnel solution was blended and left its valve in continual times for reduction of the

funnel inside pressure. In order to sorting out the organic phase from watery phase while passing from column that consist the sodium sulphate for elimination of water molecule from organic phase.

In this step, 30 ml dichloromethane was again added to that and blended to separate organic phase from watery phase. During evaporation of removed fluid by the Rotary set, the evaporation of under vacuum, thus the bulk of the acquired liquid is decreased 2–3 ml. At the end of the procedures 1 ml organic solvent chloroform was used for extracting.

The concentration reading

Standard of Malathion procured from merk India and collated from IIRT.

Taking into account to the proposed technique of Standard Method Book for measuring of Malathion toxin because the considering to the conditions of HPLC set following stages was completed:

- The standard solution was prepared from the particular poison by HPLC grade substance and with high purity percent in the different concentrations and then it was injected to HPLC set. 20.0 µ L was taken and injected to HPLC set.

The specifications of HPLC

Agilent High Performance Liquid Chromatography device (HPLC), proficientwith UV Detector and auto sampler. The applied column for sorting of these compounds is C18 (made in Agilent Company in Germany), with 4.6 mm diameter in 30° Ctemperatures and 250 mm length. The moving phase flowing velocity and the used moving phase were measured in order 1 mL/min and acetonitrile and water with ratio (47/53). The used wave length was ascertained 220 nm for revelation of these compounds. The used separating column of HPLC set was C18 kind. RT of Malathion in 10.32 minutes. The used set accuracy in research was estimated at nearly 1 µg/L. Specificity, selectivity, accuracy, LOD, LOQ and linearity tested as per CIPAC and FAO guidelines. Correlative coefficient was 0.99%.

The specifications of ultraviolet reactor

The used reactor in this study contains one closed bottom cylinder with 3 litres size and kind of the rust proof steel. In order to perform mixing of the sample for radiation in the reactor in this cylinder one magnetic stirrer has been applied. In this pilot, on account of extreme heating made the result of lamp radiation was used the chiller for lessen the temperature. For this purpose, one bocal of 4 L was used that cylinder fits its inside. The empty gap of cylinder and bocal was packed by ice for temperature reducing. All the analyses were performed according to the procedures outlined in standard methods (APHA 2005).

Calculation of Degradation Percentage

The definition of Malathion degradation percentage (DP) was as follows:

$$DP = (Cn1 - Cn2)/Cn1 \times 100$$

Where DP (%) is the degradation percentage of the ultraviolet reactor, Cn1 is the initial concentration of pesticide (mg/l).

Cn2 is the concentration of pesticide (mg/l) after reaction for (t) time.

Statistical method

The results were analysed by SPSS software, 11.5 version and 2003 excel. The data were analysed using ANOVA and t-test. The variables were irradiation time, initial concentration and pH degradation was variable depended.

The Malathion toxin was affected by ultraviolet mercurial lamp with medium pressure in 0.5, 1, 2 mg/L and 10, 20, 30, 40, 50, 60 min and pH= 6, 7, 9.

Effect of pH value

The study results of pH alteration on the utility of Malathion concentration exhibits that the usefulness of concentration rises by pH augmentation, so that Malathion in 0.5, 1, 2 concentrations and pH= 6 have the concentration efficacy 61%, 56%, 54.6 % but the determination of utility reaches to 71%, 63%, 63.6 % in pH = 9 (Fig. 1, 22 and 3).3). The analysis test of ANOVA showed in this case is the significant statistical difference too.

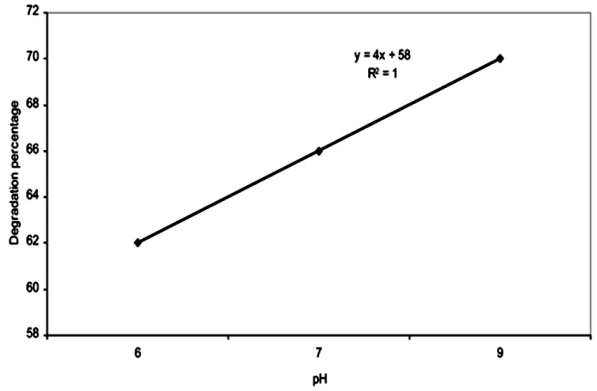

Fig. 1: Degradation percentage vs. pH for 0.5 mg/l.

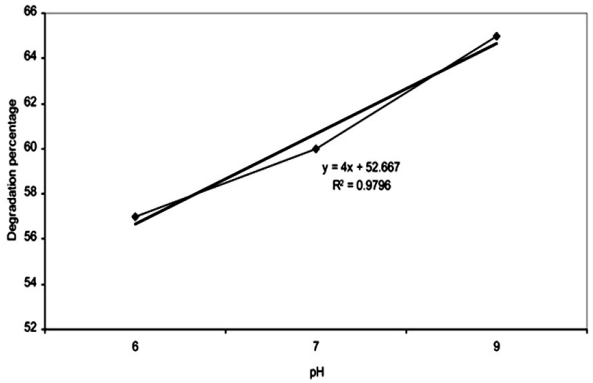

Fig. 2: Degradation percentage vs. pH for 1mg/l.

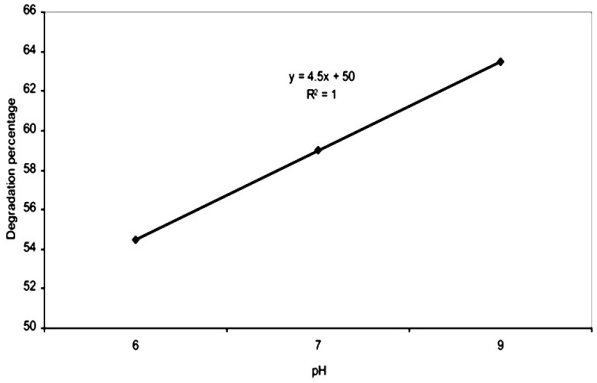

Fig. 3: Degradation percentage vs. pH for 2 mg/l.

Effect of irradiation time

The results exhibitedthat measure of Malathion toxin reduction augmentation by rising of irradiation time. The regression statistical test shows that the amount of extant poison reduces in pilot by increasing time. The analysis test of ANOVA illustrated the significant dissimilarities among times.

Effect of initial concentration

The concentration alterations are influential on the utility of ultraviolet. The determination of Malathion degradation has the most efficacies in 0.5 mg/L in 60 min period and the alkali pH among the other concentrations. In other words, by rising of toxin concentration lessens the degradation. The figures demonstrate the degradation percentage vs. time period for various concentrations of Malathion. As per ANOVA test, the result of concentration changes on efficiency is significance.

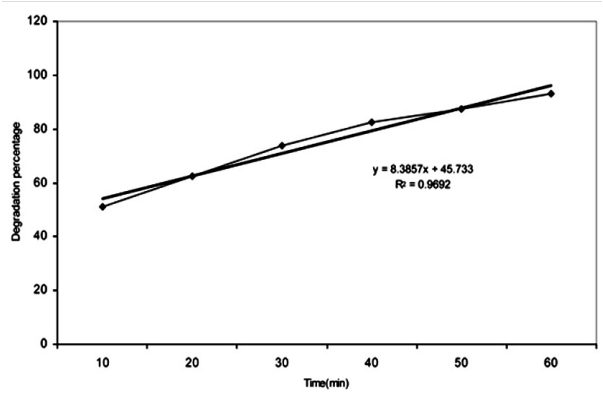

Fig. 4: Degradation percentage vs. time period for 0.5 mg/l..

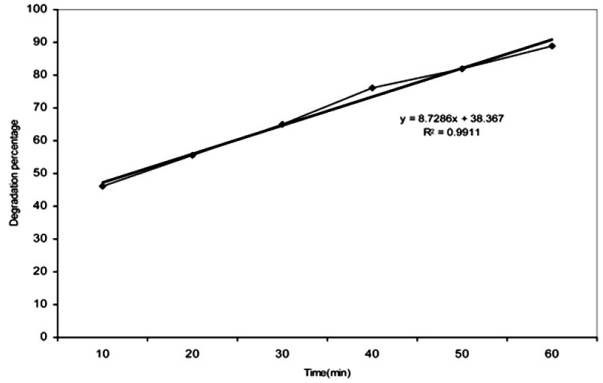

Fig. 5: Degradation percentage vs. time period for 1 mg/l.

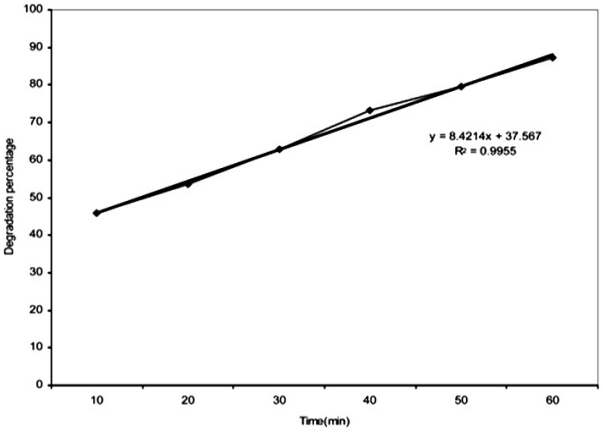

Fig. 6: Degradation percentage vs. time period for 2 mg/l.

Discussion

This experiment demonstrated that the efficiency of Malathion degradation from water by ultraviolet irradiation depends on three parameters; the initial and last concentration, the irradiation time and the pH. This investigation explained that initial concentration decreases with irradiation time. These study results conform to Khodadadi (2008), Walid et al. (2006) and Maldonado et al. (2006) too.

In other words, when the irradiation time augment, lots of free radicals has formed in the liquid and this event results to the much breakdown of Malathion poison.Khodadadi (2008) investigated pH changes in 6, 7, 9 limits on the concentration in time period of 1 hour and noted that the concentration increased by pH augmentation.

Ultimately, using chemical oxidation techniques are not too much safe and soundsince they can impose too much energy and costs in the method of water treatment. Because of this, given preference that will use the integrative technique of water refining for dropping of costs by using lower amount of energy.

Acknowledgments

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References

1. Alavanja MC, Hoppin JA, Kamel F. Health effects of chronic pesticide exposure: Cancer and nevrotoxicity. Annu Rev Public Health. 2004; 25:155–197. [PubMed] [Google Scholar]
2. APHA . Standard methods for the examination of water and wastewater. American Public Health Association; Washington, DC: 2005. [Google Scholar]
3. Borner H. Pesticides in ground and surface water. Springer Verlag; Berlin Germany: 1994. [Google Scholar]
4. Badawy MI, Montaser Y, Ghaly MY. Advanced oxidation processes for the removal of organophosphorus pesticides from wastewater. J Desalination. 2006;194:166–175. [Google Scholar]
5. BavconKralj M, Franko M, Trebše P. Photodegradation of organophosphorus insecticides: Investigations of products and their toxicity using gas chromatography–mass spectrometry and AChE-thermal lens spectrometric bioassay. J Chemosphere. 2007;67(1):99–107. [PubMed] [Google Scholar]
6. Freed VH, Chiou CT. Degradation of selected organophosphate pesticides in water and soil. J Agric Food Chem. 1979;27:706–708. [Google Scholar]
7. Héquet V, Gonzalez C, Le-Cloirec P. Photochemical processes for atrazine degradation: Methodological approach. J Water Research. 2001;35:4253–4260. [PubMed] [Google Scholar]
8. Honarpajoh K. School of Public Health, Tehran University of Medical Sciences; Iran: 2003. Survey and determination of organophosphors insecticides of Malathion and Diazinon in water of Karaj Amir Kabir Dam. [MSc Thesis]. [Google Scholar]
9. Huston PL, Pignatello JJ. Degradation of selected pesticide active ingredients and commercial formulations in water by the photo-assisted fenton reaction. J Water Research. 1999;33:1238–1246. [Google Scholar]
10. Khodadadi M. Hamadan University Medical Sciences; Iran: 2008. Determination of pesticides residue concentration in Hamadan drinking water resources and comparison of removal efficiencies of it by application of PAC and Advance oxidation by O3/UV. Hamadan. [MSPH Thesis]. [Google Scholar]
11. Maldonado MI, Malato S, Pereze- Estrada LA, Gernjak W, Oller I, Doménech X, Peral J. Partial degradation of five pesticides and an industrial pollutant by ozonation in a pilot-plant scale reactor. J Hazardous Materials. 2006;138:363–369. [PubMed] [Google Scholar]
12. Rauh A, Garfinkel R, Perera P. Impact of prenatal chlopyrifos exposure on Neurodevelopment in the First 3 years of life Among Inner- city children. J Pediatrics. 2006;118(6):1845–1859. [PMC free article] [PubMed] [Google Scholar]
13. Shayeghi M, Shahtaheri J, Selseleh M. Organophosphorus insecticides residue in Mazandaran river and waters (Iran) Iranian J Public Health. 2001;30(3–4):115–119. [Google Scholar]
14. Shayeghi M, Darabi H. Survey of Diazinon and Malathion in water of Shahpour, Mand, Dalaki, Boushehr Riverse. J South Medicine. 2004;10(1):54–60. [Google Scholar]
15. Shayeghi M, Dehghani MH, Mahvi AH, Azam K. Application of Acoustical Processor Reactors for Degradation of Diazinon from Surface Water. Iran J Arthropod-Borne Dis. 2010;4(2):11–18. [PMC free article] [PubMed] [Google Scholar]
16.] [PubMed]
17. Safi JM. Association between chronic exposure to pesticides and recorded cases of human malignancy in Gza Goveronates. J Sci Total Environm. 2002;284:75–84. [PubMed] [Google Scholar]
18. Tarahi S. Tehran University of Medical Sciences; Iran: 2002. Survey and determination of used pesticides residue concentration (malathion, diazinon and metasystox) in the water of Nahand river. [MSc Thesis]. [Google Scholar]
19. Videria RA, Antunes-Madiera MC, Lopes VI, Madeira Vítor MC. Change induced by malathion, methylparation and parathion on membrane lipid physiochemical properties correlate with their toxicity. J Biochem Biophys Acta (BBA)-Biomembranes. 2001;1511:360–368. [PubMed] [Google Scholar]
20. Walid K, Lafi Z, Al-Qodah Combined advanced oxidation and biological treatment processes for the removal of pesticides from aqueous solutions. J Hazardous Materials. 2006; B137:489–497. [PubMed] (Google Scholar)