



## Study of Efficient Ecofriendly Degradation of Some Organophosphate Pesticides Using Silver Vanadate Nanoparticles and Analytical Qualification of Their Fragmentations

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### Abstract

Organophosphates now account for roughly half of all pesticides. Due to their widespread agricultural use as pesticides on fruits and vegetables, as well as their use in mosquito abatement in public settings like parks, organophosphates are a societal health and environmental hazard. It takes a lot of time and money to monitor and remove these pollutants from the environment. As a result, this study used a novel technique based on produced silver vanadate nanoparticles to try to remove these chemicals from drinking water and wastewater. The silver vanadate nanoparticles ( $\alpha\text{-Ag}_3\text{VO}_4$ ) were created utilising a simple microwave aided process to remove several pesticide groups found in Egyptian agricultural crops and water. The effect of a fixed dose of  $\text{Ag}_3\text{VO}_4$  nanoparticles on three chemicals, chlorpyrifos, dimethoate, and malathion, was investigated at a concentration of 0.5 mg/kg of each one. After only 15 minutes of treatment with 0.1 g of  $\text{Ag}_3\text{VO}_4$  nanoparticles in methanol/water (1:1 v/v), these compounds were no longer detected on the device's chromatogram, which is regarded a short period for affecting these compounds and changing their nature in an attempt to get rid of them. After 60 minutes of treatment with the same amount of  $\text{Ag}_3\text{VO}_4$  nanoparticles, 99 percent of the chlorpyrifos dissolved in pure water was dissipated. Thermo Scientific™ Orbitrap Exploris™ 120 mass spectrometer was used to determine chlorpyrifos breakdown fragments using mass scan of the Qtrap API 6500+ LC-MS/MS System. Supported  $\text{Ag}_3\text{VO}_4$  nanoparticles could be employed in long-term environmental cleanup, according to this study, because they can be used in aqueous solutions at room temperature without requiring extra catalysis to keep the environment safe.

**KEYWORDS:** chlorpyrifos, silver vanadate, nanoparticles, LC-MS/MS.

### 1. Introduction

The use of pesticides in modern agriculture has become one of the most important necessities to meet the needs of society for food as a result of the continuous increase in the number of the population, and thus millions of tons of pesticides are used annually for this purpose [1]. Pesticides are among the most widely used chemicals. Despite the importance of using pesticides, they are considered one of the most harmful substances that affect humans, animals, and surface water in particular [2]. As a result of applying pesticides in high quantities in the environment, then they may affect surface water and through water storms may lead to a high spread of pollution, which affects aquatic

ecosystem [3]. Organophosphates are one of pesticide group used to protect plant and increase crop productivity by killing pests and insects.

Chlorpyrifos is one of the most popular organophosphate pesticides widely used for controlling pests and diseases for various crops due to its accessibility [4]. Chlorpyrifos is used as an example for the organophosphate pesticides such as dimethoate and malathion. Chlorpyrifos ( $\text{C}_9\text{H}_{11}\text{Cl}_3\text{NO}_3\text{PS}$ ) O,O-Diethyl O-3,5,6-tri chloropyridinyl-phosphonothioate is one of an organophosphate pesticide used to kill a number of pests including insects and worms. It is used on crops, animals, and buildings [5]. In the United States, chlorpyrifos was first registered in 1965 for

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the control of vegetation and soil-borne insects [6]. It is one of the most commonly used organophosphate insecticides in agriculture in the United States, and it was one of the most widely used residential insecticides until being phased out [7]. The World Health Organization rates chlorpyrifos as moderately harmful to humans. It works on the nervous system of insects by inhibiting acetylcholinesterase, and its home use was prohibited in the United States in 2001 [8]. Eye watering, increased saliva, sweating, nausea, and headache are all symptoms of Chlorpyrifos poisoning. Muscle spasms or fatigue, vomiting or diarrhoea, and vision impairment are all possible side effects of intermediate exposure. Seizures, unconsciousness, coma, and suffocation from respiratory failure are all symptoms of serious poisoning [9]. It is named an overall use pesticide GUP; General Use Pesticides and it is enrolled for agribusiness utilizes. An aggregate of 12919 examples of 57 distinct sorts of natural product vegetable and sweet-smelling restorative plants tests were inspected for chlorpyrifos buildups during 2002. Just 10.16 % of the all-out tainted products (12193 examples) were underneath cutoff of assurance (LOD = 0.02 ppm), 9.62 % at LOD or all the more anyway 80.21 % of those examples are not polluted with chlorpyrifos buildups. Just 6.33 % of the examples surpassed MRL's of chlorpyrifos buildups contrasting and public, Codex and EU-MRL's. chlorpyrifos buildup were the identified as often as possible in dry celery and cumin tests with rates of 61.54 % and 40.91 % individually and furthermore showed higher infringement rate for similar products 58.97 % and 40.91 %. The significant supporters of absolute admission of chlorpyrifos buildup are the root vegetables (81.89 %). Information showed that the all-out dietary admission of chlorpyrifos is to be 0.0045 mg/kg. Body weight/day is lower than ADI (0.01 mg/kg body weight) and contributing just 45 % of ADI. Consequently, dietary openings to chlorpyrifos are as yet not a case for Egyptian customer concern. Because of their far-reaching use, organophosphates have caused critical contamination and have amassed in soils, ground water, food harvests, vegetables, and surprisingly in creatures [10-12], accordingly, it is important to distinguish effective innovations for eliminating them from the environment.

Numerous innovations including single strategies and blends of (H<sub>2</sub>O<sub>2</sub>) [13], and chlorine (NaOCl) [14], couldn't successfully corrupt the engineered pesticides. Subsequently, some mix techniques were

utilized. The corruption as well as mineralization of chlorpyrifos was examined utilizing the Fenton reagent (H<sub>2</sub>O<sub>2</sub>/Fe<sup>2+</sup>) and demonstrated that it was successful. Besides, it has been shown that few types of microscopic organisms and growths displayed impressive limit with respect to processing chlorpyrifos in the dirt and fluid media [15-19]. Ferrate (VI) was used to study the kinetics of chlorpyrifos, an organophosphorus (OP) compound, and the ability of this iron-based chemical oxidant to remove chlorpyrifos from water and wastewater treatment [20]. Bimetallic silver/copper (Ag/Cu) nanoparticles was synthesized and then used for water purification application using the toxic pollutant, chlorpyrifos pesticide, as a model [21]. Hexacyanoferrates (MHCf) of Zn, Cu, Co, and Ni was evaluated in deprivation of selected hazardous pesticides, viz., chlorpyrifos (CP), thiamethoxam (TH), and tebuconazole (TEB). Sharp nanocubes of ZnHCF (~ 100 nm), distorted nanocubes of CuHCF (~ 100 nm), and nanospheres of CoHCF and NiHCF (< 10 nm) were synthesized [22]. Magnetically separable Fe-ZnO nanocomposites were synthesized and then evaluated the photodegradation activity of Fe-ZnO nanocomposite on an organophosphate pesticide (chlorpyrifos) at different concentration under UV irradiation and analyzed by FT-IR, Raman and UV-Vis spectroscopy [23]. Ag and Au NPs were used in both approved and unsupported types at room temperature, chlorpyrifos (CP), an organophosphorothioate pesticide, decomposes into 3,5,6-trichloro-2-pyridinol (TCP) and diethyl thiophosphate over. Absorption spectroscopy and electrospray ionization mass spectrometry were used to identify the degradation products (ESI MS) [24]. Silver vanadates were synthesized by the hydrothermal method and the investigation of their photocatalytic abilities for removing crystal violet (CV) and atrazine pollutants under visible-light irradiation [25].

The method presented in this study describes the synthesis of silver vanadate nanoparticles by a simple method and then using it in degradation of chlorpyrifos, dimethoate and malathion. The determination of these compounds was estimated using electrospray positive ionization (ESI+) by Exion HPLC coupled with SciexQtrap API 6500+ LC-MS/MS System. In this study, using mass scan of Qtrap API 6500+ LC-MS/MS System and Thermo Scientific™ Orbitrap Exploris™ 120 mass spectrometer by direct infusion scan mode to determine chlorpyrifos breakdown products. The method used before determination is simple and

take a short time to reach to these results by using low loading of silver vanadate nanoparticles.

## 2. Experimental method

### 2.1. Instrumentation and analysis

(1) LC-MS/MS System, ExionLC AC coupled with Qtrap API 6500+ MS/MS system from AB Sciex, USA.

(2) Chromatographic column, Infinity lab Poroshell 120 EC-C18 3.0 × 50 mm, 2.7 μm particle size (Agilent, USA).

The column temperature was 40°C and the injection volume was 2 μL. The pesticides are separated using Gradient mixing programme of 10% 50 mM ammonium formate in deionised water which mostly used for positive ionization mode, with 0.1% formic acid as eluent A and methanol as eluent B at 300 μL/min flow rate starting by A bottle 60% for 1 min, changed continuously till 11.5 min to be 10% for 0.5 min, changed progressively till 12 min to be 0% for 2 min and returned to 60% from A in min 14 for 2 min to be 16 min complete run time for every one of the 3 pesticides yet for one pesticide the flow rate starting by A bottle 20%, changed steadily till 3 min to be 10% for 0.5 min and returned to 20% from A in min 3.5 for 1.5 min to be 5 min all out run time. The MS/MS investigation was performed by electrospray ionization in the positive ion mode with multiple reactions monitoring (MRM) mode. The following source and gas parameters were applied: temperature, 400°C; and ion spray voltage, 5500 V.

LC mobile phase stock solution was 50 mM ammonium formate solution in methanol/water (1:9), add 1.73 mL formic acid to 900 mL water, adjust the pH to about  $3.78 \pm 0.02$  with ammonia solution (33%) and then add 100 mL methanol and LC mobile phase was 10 mM ammonium formate solution in methanol/water (1:9), dilute 200 mL of LC mobile phase stock solution with 800 mL methanol/water (1:9), the pH should be  $4 \pm 0.1$ , adjust if necessary.

(3) Thermo Scientific™ Orbitrap Exploris™ 120 mass spectrometer from Thermo Scientific, USA.

(4) Chromatographic column, ZORBAX Eclipse Plus C18 4.6 × 150 mm, 5 μm particle size (Phenomenex, Torrance, CA, USA).

### 2.2. Reagents and materials

Chlorpyrifos (97%), Dimethoate (98.5%) and Malathion (99%) were purchased from Dr. Ehrenstorfer (Augsburg, Germany). Methanol (99.9%) HPLC grade was purchased from J.T. Baker (PA, USA). Silver nitrate (99.8-100.5%) HPLC was purchased from Sigma Aldrich. Ammonium metavanadate (99%) HPLC was

purchased from Sigma Aldrich. Deionized water (<18M<sub>cm</sub> resistivity) was performed in the laboratory using a Millipore (Billerica, MA, USA) MilliQ water purification system. Ammonia solution (33%) was purchased from Riedel-de Hën (Seelze, Germany). Formic acid (98–100%) was purchased from Riedel-de Hën.

#### 2.2.1. Standard preparation

Stock solutions (1000 μg/mL) of each pesticide standard were prepared by dissolving chlorpyrifos, dimethoate and malathion in toluene. All stock solutions were prepared and kept at  $-20 \pm 2^\circ\text{C}$ . Working mixture standard solution of the studied pesticides (20 μg/mL, each) and calibration mixtures of concentration levels 0.01, 0.05 and 0.5 μg/mL were prepared by diluting suitable aliquot of the stock solutions with methanol stored at  $4 \pm 2^\circ\text{C}$  while we do not need any calibration levels out of the identification concentration.

### 2.3. Experimental procedure

#### 2.3.1. Synthesis of silver vanadate ( $\alpha\text{-Ag}_3\text{VO}_4$ ) nanoparticles

In a standard synthesis technique, a particular amount of  $\text{AgNO}_3$  was dissolved in deionized water and then poured drop wisely into a container holding ammonium metavanadate ( $\text{NH}_4\text{VO}_3$ ) solution with ultrasonic stirring at room temperature for 30 minutes. The pH of colored suspension was adjusted to near 7 using ammonia solution and ultrasonic stirring continued to 3 hours. The starting silver-to-vanadium molar ratio was retained at 3:1, as suggested by prior investigations, which suggested that the supplied silver vanadate with this stoichiometric ratio could be promising catalysts for wastewater treatment [26, 27]. The obtained suspension was then transferred into Teflon-lined vessel and placed in a microwave oven operating at 2.5 GHz and maximum power of 650W at 160°C for 2 hours. The resulting precipitate was filtered and washed several times with deionized water and ethanol using centrifuge for 5 minutes at 13000 rpm at each time. After washing, the precipitate was dried at 80°C for 24 hours. At long last the subsequent powder was granulated well to utilize it. (Figures S1 and S2) exhibit, respectively, XRD and HR-TEM analyses of the synthesized  $\alpha\text{-Ag}_3\text{VO}_4$  nanoparticles.

#### 2.3.2. Degradation of pesticides using $\alpha\text{-Ag}_3\text{VO}_4$ nanoparticles

The procedure involves 0.1 g of  $\alpha\text{-Ag}_3\text{VO}_4$  nanoparticles were added to 100 ml of mixture of pesticides 0.5 μg/mL dissolved in methanol/water (1:1 v/v) using a magnetic stirring to reach equilibrium. The previous step was repeated again with dissolving chlorpyrifos in water only as an

example for 3 pesticides. At chosen time intervals, sample aliquots were collected, centrifuged for 5 min at 4000 rpm (3430 rcf) and filtered using syringe filters (0.45  $\mu\text{m}$ ) and then transferred to Polypropylene (PP) vial. Finally, the filtrates were further analyzed by LC-MS/MS. The previous steps were repeated again with each pesticide that affected individually. This experiment was conducted repeated several times in dark and visible light using UV lamp at 365 nm and without it at room temperature. The final solution of chlorpyrifos after the fragmentation was injected to Qtrap API 6500+ mass spectrometer and Thermo Scientific™ Orbitrap Exploris™ 120 mass spectrometer by direct infusion scan mode as an example for 3 pesticides.

### 3. Result and discussion

A chemical remediation study was evaluated to reducing chlorpyrifos risk from irrigation water. Some chemicals used as catalyst were prepared in nanoparticle phase and were tested in vitro to check their ability to cracking out tested pesticide. An analytical study was used to evaluate catalysts efficiency and the environmental fate for chlorpyrifos using liquid chromatography tandem mass spectrometry. In previous studies the use of gas chromatography coupled with single mass were used to checks compounds with and without a chemical fragmentation test, Also infra-red and NMR determination were used to support compound fate structures. In this investigation a tandem mass was used for the determination of chlorpyrifos breakdown products by using mass scan before multiple reactions monitoring mechanism as a finger prints for the chemical reaction products and also to have relationship between the main compound and its founded products.

Different groups of pesticides were tested by silver vanadate nanoparticles in visible light at room temperature for 24 hours, only 3 pesticides (chlorpyrifos, dimethoate, malation) were affected till be displayed from solution test, Its clearly they relationships to each other as a organophosphate classification which led us to physicochemical theory about the reaction of silver vanadate nanoparticle to breakdown persisted pesticides in environment specially in irrigation water and waste water. The dissipation in 15 min for chlorpyrifos and dimethoat while malation was more resist for more 30 min as shown in (Table 1).

(Table 1) showed dramatically dissipation in 15 min for chlorpyrifos and dimethoat while malation was more resist for more 30 min.

Also, chlorpyrifos was tested in pure water to compare the difference between dissipation rate in laboratory solution (methanol/water (1:1 v/v)) and open field (water) which resulted similar behavior that was shown in (Table 2).

Table 2 showed dramatically dissipation for chlorpyrifos in water in 60 min.

An analytical study was done to investigate chlorpyrifos breakdown fragments using tandem mass spectrometry (Q trap) and hybrid orbitap technique using 4 decimal points with high resolution mass filter for mass scanning and exact mass determination. Chlorpyrifos and its breakdown derivatives were scanned and determined as a way to investigate bonds breaking pathway.

(Figure 1) showed the mass scan of chlorpyrifos by first mass filter including the isotopic distribution of compound due to the present of 3 chlorine atoms, After scanning 350 Dalton was used as mass separation for parent chlorpyrifos in Q1 before special fragmentation in collision cell for two fragments (274 and 198), then Q3 was used as linear ion trap for filtering each fragment before second fragmentation and scanning to find up third mass part from analyte (MS/MS/MS).

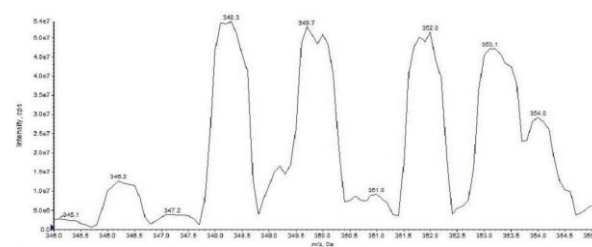


Figure 1. Choropyrifos (0.1 mg/kg) scanning using Q1 of tandem mass

A specific test was done to compare between chemical and instrumental fragmentation as a way to confirm that the founded fragments by nano material were also similar to that produced by instrument. (Figures 2 and 3) showed two different fragments comes from two fragments from chlorpyrifos (350,274,144 and 350,198,107) as a triple followed mass separation using linear ion trap for tested analyte. The present of 144 Dalton fragment ion was due to the loss of  $\text{H}_2\text{O} + \text{Cl}$  when the other fragment 107 was due  $\text{CO}_2 + \text{Cl} + \text{HCN}$  losses [24]. From the other hand, multiple reactions monitoring mechanism was used to determine all founded compounds in the solution after one day

from chlorpyrifos silver vanadate nanoparticles reaction.

(Figure 4) showed the full scan results found in solution before optimizing best energy and mass unit voltage to find up fragments for these compounds derivatives.

(Figures 5 and 6) showed the products of two chosen breakdown fragments after nano treatment, the first one was 274 which was broken to 5 detected fragments under instrumental fragmentation and the other was 198 gives 2 fragments one of them was found as a third product to main chlorpyrifos, this result led us to similar findings between chemical and instrumental degradation. Moreover, the present of 198, 199.8 and 202 masses were due to  $^{35}\text{Cl}^{13}$ ,  $^{35}\text{Cl}^{12}$   $^{37}\text{Cl}$ , and  $^{35}\text{Cl}^{37}\text{Cl}^{12}$  isotopes of TCP (3,5,6-trichloro-2-pyridinol) respectively.

Mass determination with high resolution was studied using hybrid orbitrap mass spectrometry. A high accuracy scan ranged between 85 to 355 Dalton was done for tested solution after nano reaction as shown in (Figure 7) (full scan); instrumental method was adjusted for both scanning and special fragmentation for any founded masses between target ranges. Four masses were found in confirming with previous test (Qtrap-6500+): 282.2728, 274.2681, 197.9231, 169.0587 and 242.1485.

As showed in (Figure 8) the fragments ions with high abundance produced by founded masses after nano reaction were found 113.0000, 106.9451, 108.9423, 209.1536 and 96.0704 respectively which were supported by the triple quadrupole mass instrument and led us to have good idea about the breakdown pathway of chlorpyrifos pesticide after remediation reaction with nano silver vanadate.

This data was in agreement with that found before, the products produced by silver nitrate nanoparticles reaction in 48 hours led to protonated TCP 198 Dalton which produced 144 and 107 Dalton fragments when using 3200 QTrap MS/MS instrument [24]. Also an accurate mass of 197.9235 was found when scanning chlorpyrifos after Fe oxidation using Triple TOF 5600 mass spectrometry instrument [20]. On the other hand, the presence of 107 as a fragment product from both parents 198 and 274 can explain a possible structure of 274 which was supported in the shown spectrum of TOF triple mass for chlorpyrifos fragmentation [20]. The use of silver/copper nanoparticles as a catalysts for chlorpyrifos degradation led to TCP and DETP (Diethyl thiophosphate) [21].

Possible structures for chlorpyrifos breakdowns were described using the founded masses in (Figure

9) using scan mode of 6500+ QTrap. These possible structures were supported by accurate mass (4 decimal points) scanning using Orbitrap in (Figure 7) which explained the possible pathway of chlorpyrifos after nano silver vanadate examination. Five possible fragments could be described as follow: 282 could be found due to the loss of 2 chlorine atoms by a substitution reaction using hydroxyl (OH) radical produced by nano silver vanadate while the oxygen ( $\text{O}_2^-$ ) radical was necessary for breaking the ring in nitrogen site by oxidation reaction to produces 274 and 242 fragments. On the other hand, 198 and 174 mass fragments were produced by the hydrolysis in between pyridinol ring and thiophosphate group to produce 3,5,6-trichloro-2-pyridinol (TCP) and diethyl thiophosphate. These commentaries were in agreement with a fact which describes the breakdown of atrazine using nano silver vanadate as a de-chlorination, hydroxylation and alkylic oxidation in ethyl chain [25]. Chlorpyrifos pathway in (Figure 10) showed 4 possible fragments due to nano silver vanadate treatment, three different sites were found to be the target for nano silver vanadate. Moreover, these three active sites; C-Cl, C-N in the pyridinol ring and C-O in between pyridinol ring and thiophosphate group, led us to these breakdown products.

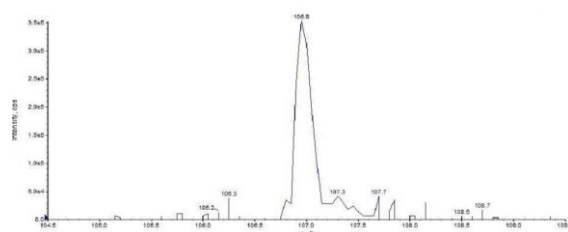


Figure 2. Chlorpyrifos MS/MS/MS scanning included two followed fragmentation step using linear ion trap (350,198,107).

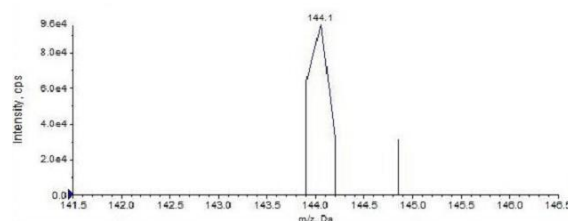


Figure 3. Chlorpyrifos MS/MS/MS scanning included two followed fragmentation step using linear ion trap (350,274,144).

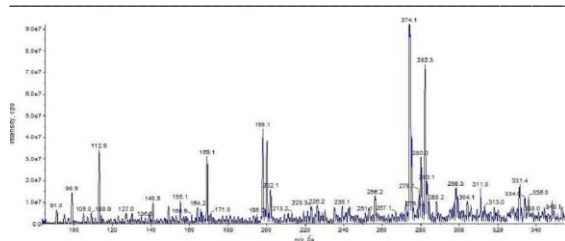


Figure 4. Full scan spectrum for chlorpyrifos derivatives using first quadrupoles Q1

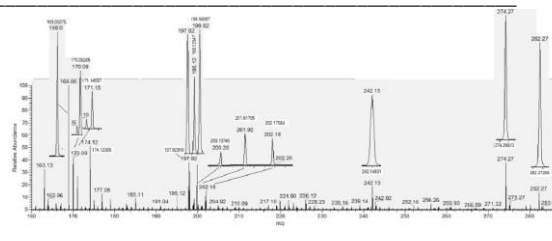


Figure 7. Total ions chromatogram for all residues after nanoparticles reaction using Orbitrap scanning mode

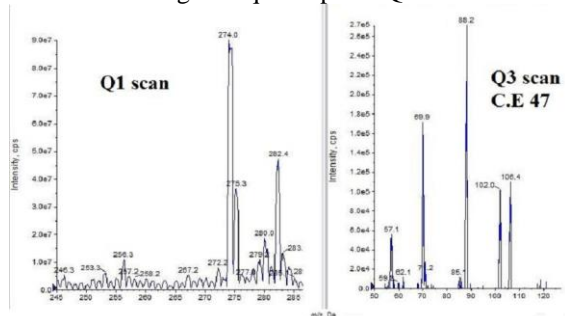


Figure 5. MRM optimization for 274 parent with C.E 47 and fragments scan

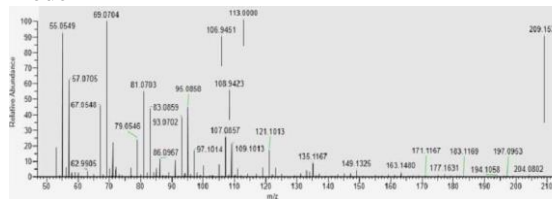


Figure 8. The highest abundance fragments ions produced after reaction using Orbitrap MS2.

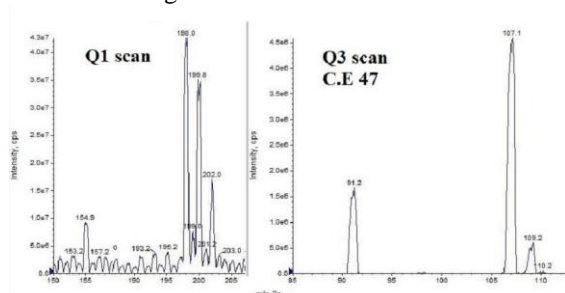


Figure 6. MRM optimization for 198 parent with C.E 47 and fragments scan

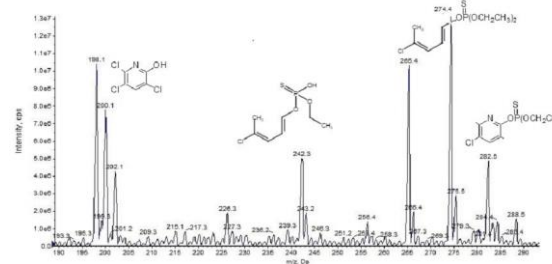


Figure 9. Big Q1 scanning from the most high abundance fragments produced after reaction and its possible structures.

Table 1: Tested pesticides breakdown and dissipation rate after nanoparticles fragmentation reaction.

B.D. Reagent (AgVO <sub>3</sub> )	Chlorpyrifos (0.5 mg / kg)			Dimethoate (0.5 mg / kg)			Malathion (0.5 mg / kg)		
	P. area	A. Conc.	D. Rate	P. area	A. Conc.	D. Rate	P. area	A. Conc.	D. Rate
before adding	1.26E+08	0.499	0%	7.67E+07	0.495	0%	1.44E+08	0.499	0%
after 1 min	1.03E+08	0.404	19.0%	6.94E+07	0.448	9.5%	1.29E+08	0.446	10.6%
after 5 min	2.19E+07	0.0865	82.7%	4.49E+07	0.29	41.4%	9.06E+07	0.313	37.3%
after 15 min	7.65E+06	0.0302	93.9%	8.30E+06	0.0536	89.2%	4.43E+07	0.153	69.3%
after 30 min		N.D		4.37E+05	0.00282	99.4%	2.20E+07	0.0762	84.7%
after 45 min					N.D		1.44E+07	0.0498	90.0%
after 60 min								N.D	

B. D.: breakdown, P: peak, A. Conc.: analyte concentration and D: dissipation

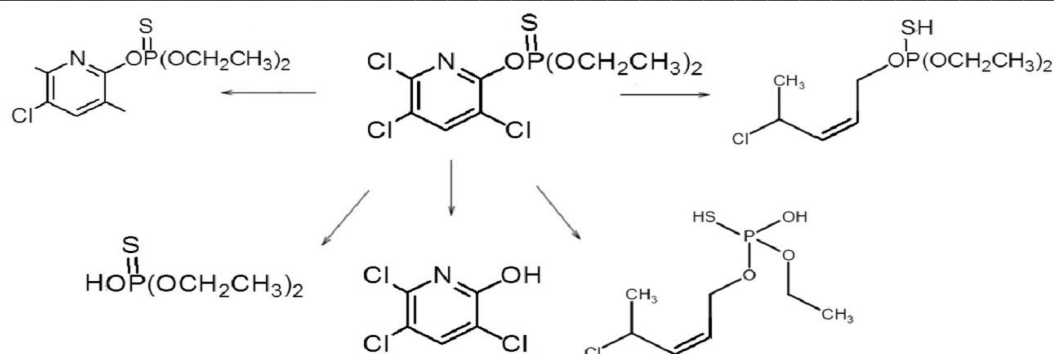


Figure 10. The possible pathway for chlorpyrifos breakdowns.

Table 2: Tested chlorpyrifos breakdown in water and dissipation rate after nanoparticles fragmentation reaction.

B.D. Reagent (AgVO <sub>3</sub> )	Chlorpyrifos (0.5 mg / kg)	
	A. Conc.	D. Rate
before adding	0.449	10%
after 1 min	0.219	56%
after 5 min	0.0858	83%
after 15 min	0.0299	94%
after 30 min	0.012	98%
after 60 min	0.00592	99%

B.D.: breakdown, A. Conc.: analyte concentration and D: dissipation

#### 4. Conclusion

The present study used a mass scan of the Qtrap API 6500+ LC-MS/MS system and the Thermo Scientific Q Exactive Focus Orbitrap LC-MS/MS system to establish a rapid and simple method for determining chlorpyrifos breakdown products after addition of synthesized ( $\alpha$ -Ag<sub>3</sub>VO<sub>4</sub>) nanoparticles. The addition of 0.1 g of  $\alpha$ -Ag<sub>3</sub>VO<sub>4</sub> was enough to decompose 0.5 mg/kg of chlorpyrifos, dimethoate and malathion in 100 ml water/ methanol (1:1 v/v) at room temperature in 15 minutes, which was regarded as a short period. In order to maintain the environment safer and cleaner, the experiment was redone using pure H<sub>2</sub>O as an ecofriendly solvent. The addition of nanoparticles was carried out at different ranges of concentrations of these chemicals up to 5 mg/kg and gave the same results. These chemicals were identified using an electrospray positive ionization (ESI+) by an Exion HPLC paired with a SciexQtrap API 6500+ LC-MS/MS system. To determine chlorpyrifos breakdown products, the mass scans of the Qtrap API 6500+ LC-MS/MS System and the Thermo Scientific Q Exactive Focus Orbitrap LC-MS/MS system were employed by the separation of mass using 4 decimal points to confirm the data by high resolution mass filter. Good results were obtained when the experiment was carried out in visible light at room temperature. The breakdown products of

chlorpyrifos were obtained in a short amount of time, demonstrating the clear action of manufactured nanoparticles. The synthesized silver vanadate nanoparticles may be used as a packed filter and may be put in TEFLON filter membrane to avoid its spread in water and keep the environment to be safe, its efficiency may be increased by adding an element as a nano composite material. The fact that degradation occurs at room temperature and on supported NPs, on the other hand, is significant since it allows such materials to be used for water filtration. In such cases, a post degradation phase using adsorbents such as activated carbon is required to remove the degradation products. Toxicity of these breakdown products are out of the scope of this research work, so it is the second step after further studies and more further degradation with new techniques through the environmental friendly nano composite catalyst to reach the most powerful degradation with non toxic products.

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the European Accreditation Center for Laboratories (EAL) based on ISO/IEC 17025.

#### Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Islam R. Ghoniem, Hassan A. El- Gammal, Ashraf M. Elmarsafy, Mohamed A. Amer, Mohamed M. Abo Aly and Mostafa A. Sayed. The first draft of the manuscript was written by Islam R. Ghoniem and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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#### Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### Declarations

The authors declare no competing interests.

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