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Pesticides Remediation from Soil and Water Accessing to Zero Residue Level

Mohammed Nsaif Abbas[1], Abdul-Sahib T. Al-Madhhachi*[2]
[1]Department of Environmental Engineering, Al-Mustansiriyah University, Baghdad, Iraq
*[2]Department of Environmental Engineering, Al-Mustansiriyah University, Baghdad, Iraq

ABSTRACT

Contamination of soil and water with various types of pesticides, resulting from accidental spills at agrochemical manufacturing, formulation, and distribution facilities, farm loading/washdown sites, or abandoned waste sites, is a serious environmental problem in many places in the world. The remediation of two types of pesticides which were (pirimicarb and imidacloprid) from three types of Iraqi soils (sandy, silty loam, and clayey) was investigated in this study. The treatment process for soils was carried out through washing method using distilled water in a packed bed column then; a continuous fixed bed unit was used to perform the removal of the same two types of pesticides from wasted washing polluted water using adsorption technique at different operating conditions with low-cost adsorbents: watermelon peel (WP) and used tea leaves (UTL). The results show that the maximum removal efficiencies of pesticide from polluted soils were 75.375, 86.283, and 99.786 percentage for clayey, silty loam, and sandy soils, respectively, of pirimicarb pesticides, and 71.651, 77.708, and 93.278 percentage for clayey, silty loam, and sandy soils, respectively, of imidacloprid pesticides. Finally, in this study a novel way was suggested and experimented as a safe, economic, beneficial, and eco-friendly non-conventional method to get rid of the WP and UTL loaded with pirimicarb and imidacloprid pesticides wasted. This method was trying to convert these toxic residues to applicable useful material like rodenticide. The results show that good ability for these residues to be an active rodenticide through the calculated mean lethal dosage, LD_{50}.

Keywords: Pirimicarb pesticides, imidacloprid pesticides, watermelon peel, used tea leaves

I. INTRODUCTION

Soil can be defined as the top layer of the earth's surface in which plants can grow, consisting of rock and mineral particles mixed with decayed organic matter and having the capability of retaining water. It is associated with everything around us and represents many paramount functions in perpetuating life on the planet (MacBean, 2012). Soil plays seven important roles which were providing the basis for food and biomass production, controlling and regulating environmental interactions regulating water flow and quality, storing carbon and maintaining the balance of gases in the air, providing valued habitats and sustaining biodiversity, providing a platform for buildings and roads, providing raw material and preserving cultural and archaeological heritage (Singh, 2008; Kumar et al., 2013). On the other hand, water is one of the most essential elements to health and is so important that our bodies actually have specific drought management system in place to prevent dehydration and ensure our survival (Abbas, 2014a). Water serves as a lubricant in digestion and almost all other body processes, regulates our bodies temperature, removes harmful toxins from the body in many different ways, transports valuable nutrients and oxygen throughout the body (Abbas, 2014a).

Water is the lifeblood and the most important resource of natural resources on the earth. The lives of all living organisms, agriculture, and industry depend on the water; so it's not surprising to find that most ancient human civilizations focused around the rivers and water sources such as the civilizations of Mesopotamia and the Nile Valley (Abbas, 2014a). A synopsis of the foregoing there are permanent and large correlative between soil and water in almost every place on the blue planet's surface. Alternatively, soil without water become a dead, barren, desolate and wasteland no life in it for any creature. Together these two important elements constitute two-thirds of the environment (Abbas, 2014b). Therefore, it is incumbent upon the human preserved soil and water from all problems lead to ravage or damage them. Whether these problems were naturally (such as earthquakes, volcanoes, floods, mudslides, and erosion) or human made due to continuous development sought by accessing for luxury and comfort (Đurović et al., 2009; Karim and Adnan, 2012).

The most important and serious problem for both soil and water is pollution. Pollution may be defined as “any change occurs on the elements involved in the composition of it either directly or indirectly manner due to human activity”, which makes the soil or water has less validity of uses for natural uses allocated to them or some of them. In other words, pollution is “the changes occur in the natural biological and chemical properties of soil or water, making it unfit for drinking or household use, industrial and agricultural” (Khuntong et al., 2010). Soil and water are contaminated through the waste of humanity, plant, heavy metals, agricultural, industrial, and toxic chemicals draining into the water sources such as water bodies, rivers, lakes, bays, and oceans (Wang, 2000). Also, groundwater is polluted as a result of a chemical as well as sewage spill, and later to soil including the harmful substances, bacteria, microorganisms, and pathogens (Abbas, 2014b). Many of human activities on the environment cause pollution for both soil and water; therefore, there are many sources of pollution, such as sewage, heavy metals, radioactive contaminants, dyes wasted from textile factories, petroleum extraction and refining of oil, as well as pesticide contamination (Changa et al., 2012; Abbas, 2014c).

Because of the agricultural expansion taking place in all regions and countries of the world due to rise the demand for food as a result of increasing the population growth and the threat formed by this agricultural expansion on the depletion of soil and water resources. Another problem associated with agricultural expansion and depletion of soil and water have emerged, namely, the extensive use of agricultural fertilizers and pesticides. Pesticides are chemical substances which kill or inhibit or limit the proliferation and spread of organisms that compete human in nutrition, health and property (Pets) (Alalm and Tawfik, 2013). Chemical pesticide became in general, one of the modern technological means adopted to increase agricultural production and to combat deadly diseases to humans and animals. However, these chemical pesticides have many adverse impacts, if not used according to precise criteria (Xiong et al., 2011). Recently, emerged the problem of increasing the amounts of chemical pesticides in the soil, surface, and groundwater globally, where many studies have been shown that the presence of chemical pesticides in these two elements, and as a result the attention of environmental scientists and researchers were growing with contamination of soil and water with chemical pesticides has significantly increased (Valičkováa et al., 2013). Chemical pesticide is considered from the most important environmental contaminants to their comprehensive impact on all living components of the environment, including its impact on the ecological balance, especially in third world countries, they led to serious pollution of the food eating, water drinking, breathing air, and soil that eating its benevolence (Jokanovic, 2012; Jilani, 2013). Existing technologies to remove pesticides pollutants from soil or water included many problems during and after treatment process and have several downsides such as their high costs for operation, need particular equipment, consume high energy, decreases the efficiency of remediation during the process, long time for treatment, continuous perpetuate, and often generate huge amounts of remaining toxic by-products which required safe way to poses. Therefore, the conventional treatments are no longer able to achieve required treated water quality (Marincas et al., 2009; Campo et. al., 2013).

Adsorption method has been demonstrated to be an excellent technique to remediate pesticides in comparison with other traditional methods through various importance, usefulness, and advantages properties such as high efficiency, low initial operating cost, simplicity of design, comfort of operation, economic, insensitivity to toxic substances, suitable for most types of contaminated water, and complete removal of contaminants even from dilute solutions (Abbas and Abbas, 2014). Many non-conventional low-cost adsorbents, including agricultural wastes or industrial by-products are different degrees of success in applying for the treatment of the pesticides effluents.

Compared to conventional adsorbent (activated carbon), this kind of adsorbent show a lot of advantages like readily and local available, technical feasibility, inexpensive, engineering applicability, and disposable without regeneration (Abbas and Abbas, 2014).

The objective of this study is to investigate the removal of two types of pesticides: pirimicarb and imidacloprid; from three different types of Iraqi soils. Washing water in packed bed column and removal them from washing water wasted using a renowned, low cost, and available agricultural wastes were utilized in this research. The watermelon peel, WP, and used tea leaves, UTL, as a natural adsorbent media to commercial adsorbent material existing in continuous mods, were utilized. Finally, this research is trying to benefit from the wastes residue by preparing a simple rodenticide accessing to Zero Residue Level (ZRL).

II. METHODS AND MATERIAL

A. Soil Properties

Three kinds of soils: clayey, silty loam, and sandy were utilized in this study. Clayey and sandy soil samples were obtained from the Soil Laboratory at Civil Engineering Department, College of Engineering, Al-Mustansiriyah University. The third type of soil (Silty loam) was acquired from the top layer (0–15 cm) of a field site located at Agriculture College Campus, Baghdad University, Abu-Ghraib, Baghdad, Iraq. This soil contained no detectable amount of pirimicarb and imidacloprid pesticide residues. The soils were tested and analysis according to ASTM standards (Table 1). All above soil samples were air-dried at room temperature, mixed thoroughly, and sieved to 2mm to remove stones and debris before treated with pesticides (before polluted). Soil samples were stored at room temperature for seven days before analyzed in the Laboratory. The physicochemical properties of three diffrent of soils are shown in Table I.

B. Stock Solutions

In order to avoid interference with other elements that may be presented in the real soil or water, the remediation experiments of two types of pesticides were carried out using simulated aqueous solutions of pesticides. A quantity of 1000 mg/l stock from each type of pesticide solution was prepared by dissolving a known weight of each pesticide in 1 liter of distilled water. All solutions used in the experiments were prepared by diluting the stock solution with distilled water to the desired concentration. The pesticide concentrations were measured using a spectrophotometer thermo-Genesys 10 UV.

TABLE I
PHYSICOCHEMICAL PROPERTIES OF THE THREE TYPES OF IRAQI SOILS USED IN THIS STUDY

Soil Type	Soil Texture (%)		Soil pH	OMC %	EC (ms/cm)	CEC (meq/100g)
Sandy	Sand	96.3	6.54	0.94	0.56	14.73
	Silt	3.7				
	Clay	-----				
Silty loam	Sand	22	7.8	0.14	4.00	21.40
	Silt	52				
	Clay	26				
Clayey	Sand	-----	6.34	2.32	6.10	24.75
	Silt	35				
	Clay	65				

C. Calibration Curves

The calibration curves of two types of pesticides were carried out using a spectrophotometer thermo-Genesys 10 UV. The spectrophotometer was installed using manufacture's instruction with the wave length corresponding to pirimicarb and imidacloprid pesticides. The spectrophotometer device was firstly set to zero absorbance using the blank solution. Absorbance at λ = 245 nm and λ= 270 nm for pirimicarb and imidacloprid, respectively, were determined using several experiments with dilute solution samples. From the determined absorbance above, it can prepare the calibration curves for the two types of pesticides (Figs. 1 and 2).

D. Preparation of Simulated Soil (Polluted Soil)

Five grams of each soil sample was added to 250 ml conical flasks containing 100 ml of solution having 100 mg/l of each pirimicarb and imidacloprid. All experiments were duplicated and conducted at nearly constant room temperature (28°C±2). The mixture was reserved in an orbital shaker at agitation speed of 150 rpm over night while pH of pesticide solution was reserved at the same of the soil without change. From the flasks, 5 ml of samples were acquired at regular intervals (every 15 minutes) using a clean syringe from the aqueous phase, centrifuged at 4000 rpm for 10 min, and the supernatant passed through 0.45 µm PTFE syringe filter and then put it in the spectrometric device to determine the rest of pesticide in the solution until reach equilibrium. Finally, the equilibrium concentration of pirimicarb pesticide adsorbed by the Iraqi soils was 19.7541, 16.9107, and 8.5879 g/kg for clayey, silty loam, and sandy, respectively. While the equilibrium concentration of imidacloprid pesticide adsorbed by the Iraqi soils was 15.4316, 11.4414, and 6.8825 g/kg for clayey, silty loam, and sandy, respectively.

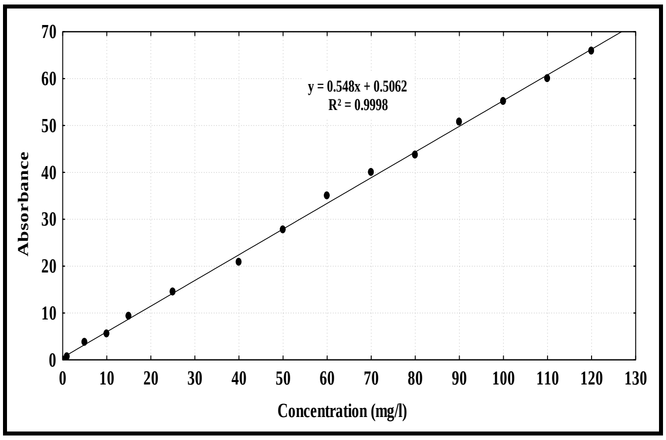

Figure 1: Pirimicarb pesticide calibration curve

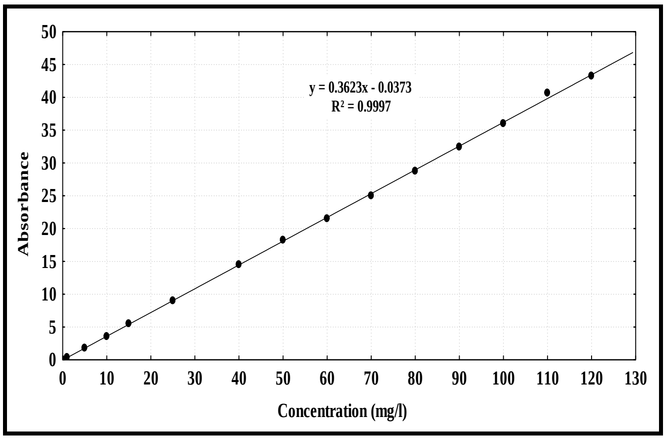

Figure 2: Imidacloprid pesticide calibration curve

E. Adsorbent Medias

1) **Preparation**: A Mature watermelon peels (WP) and used tea leaves (UTL) were obtained freely from the domestic usage (Figs. 3 and 4). The collected WP and UTL were excess washing with distilled water for removing any impurities, dust, and other filth particles or other fine dirt particles that may be stucked in the surface of WP and UTL. The washed WP was cut into 0.5 to 1 cm small pieces, and then WP and UTL pieces dried for 24 hours at 50°C. The dried WP and UTL were crushed and sieved to 0.6 mm size.

Figure 3: Watermelon peel (WP)

Figure 4: Used tea leaves (UTL)

2) **Specific surface area and porosity**: Specific surface area of WP and UTL were determined using nitrogen (N_2) physical adsorption isotherm data on the surface of the WP and UTL by Brunauer Emmett and Teller (BET) method. The samples measured at Catalysts Department in the Center of Petroleum Research and Development – Ministry of Oil, Baghdad, using (ASAP 2020, Micromerities Co., USA) and (surface area analyzer, Qsurf M1, Thermo CO., USA) devices.

3) **Scanning Electron Microscopy (SEM)**: Scanning Electron Microscopy (SEM) is one of the most versatile and well-known analytical techniques. Compared to conventional optical microscopes, an electron microscope offers advantages including high

magnification, large depth of focus, great resolution and ease of sample preparation and observation. WP and UTL samples were subjected to SEM measurement at the Central Service laboratory in College of Education, Pure Science, Ibn Al-Haitham – Baghdad University, using the following procedure. The samples were sputter coated with gold using (Fine coat JFC-1100E, JEOL Co., Japan) ion sputter in order to reduce charging effect until the thickness of the coated gold was 200 Å. Then, the coated samples scanned using SEM device (multi-function scanning electron microscope model AIS 2300C Angstrom, USA).

F. Continuous Packed Bed Unit Experiments

The remediation process of pesticides from contaminated soils was achieved by wash processing using distilled water for each soil samples prepared alone in continuous packed bed unit as shown in Fig. 5. The unit was consisting of plastic container for distilled washing water of 5 liters capacity and two packed bed columns. The first one was 5 cm in diameter and 50 cm height, and packed with prepared contaminated soil sample to 40 cm height separated from top and bottom with small nylon beads. This column was used to treat the contaminated soil by receiving washing distilled water from the container at different flow rates. To determine the concentration of pesticide removal from the different kinds of soils and transferred to washing water, samples were acquired periodically from the bottom of the column, centrifuged at 4000 rpm and tested spectrophotometrically. The removal of pesticides from washing water wasted from the first packed bed column was performed in the second packed bed column by adsorption method. This column was similar to the first one in dimensions but packed with adsorbent media (i.e. watermelon peel, WP, or used tea leaves, UTL).

Adsorption column of continuous mode experiments were conducted in order to test pirimicarb and imidacloprid removal by treated contaminated washing water with pesticides each one alone at various bed heights of the adsorbent media (i.e. WP or UTL) and different flow rates of contaminated washing water of pesticide. After the two packed bed columns were lodging and putting the required amount of soil and adsorbent media. The treatment processes was started by allowing the distilled washing water flow through the first packed bed column from the container through the first pump at a precise flow rate in experiment which was adjusted by the valve and rotameter (Fig. 5). Then, the contaminated washing water was leaving the first column and enters the second packed bed by the second pump at the desired flow rate. To determine the best operation conditions, the experiments were carried out at various flow rates for both feeds of two packed bed columns in the unit which was between 10 to 100 ml/min and the height of adsorbent media which was ranged from 10 to 40 cm. All experiments were carried out at nearly constant room temperature at 28°C±2.

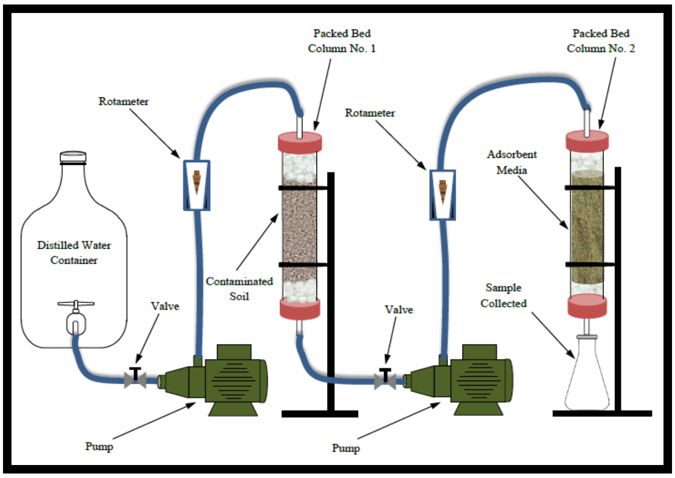

Figure 5: A schematic of continuous packed bed unit

III. RESULTS AND DISCUSSION

A. Removal of Pesticides from Simulated Soils

The effects of treatment time on desorption removal efficiency of two types of pesticides from contaminated simulated soils in packed bed are shown in Figs. 6 and 7. These figures indicate that the two types of pesticides (pirimicarb and imidacloprid) were rapidly desorbed from the three different types of soils (clayey, silty loam, and sandy) initially due to the large difference in concentration gradient between soils and distilled washing water.

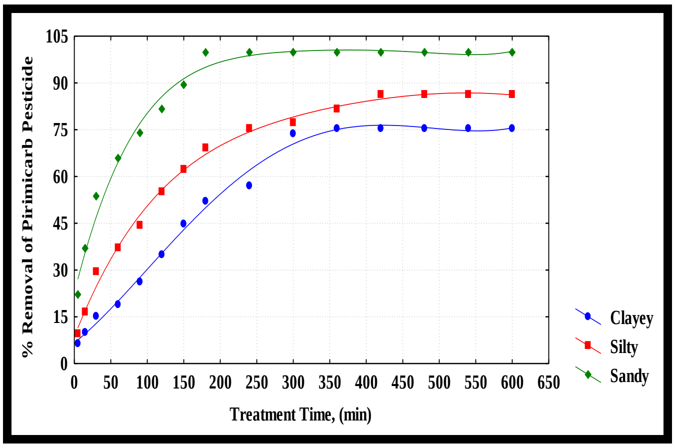

Figure 6: Effect of contact time on the % removal of pirimicarb pesticide from three different types of Iraqi soils using distilled washing water

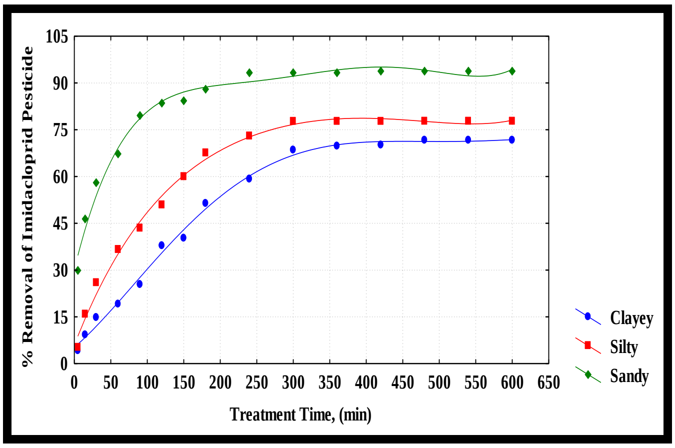

Figure 7: Effect of contact time on the % removal of imidacloprid pesticide from three different types of Iraqi soils using distilled washing water

When the concentration of pesticides in soil and washing water nearly reached to the equilibrium (i.e. nearly stay constant), pesticides still continuously desorbed albeit at a slower rate than the rate at the beginning. At the final state, equilibrium in desorption of pesticides may be conducted. The percentage removal of pirimicarb was 75.375 at 360 min, 86.283 at 420 min and 99.786 at 180 min for clayey, silty loam and sandy soils, respectively. While the percentage removal for imidacloprid pesticide was 71.651 at 480 min, 77.708 at 300 min and 93.278 at 240 min for clayey, silty loam and sandy soils, respectively.

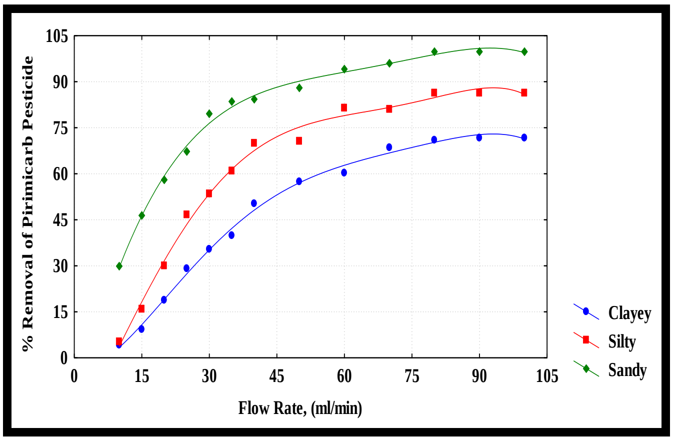

Figure 8: Effect of flow rate on the % removal of pirimicarb pesticide from three different types of Iraqi soils using distilled washing water

The effect of flow rate of distilled washing water on desorption efficiency of two types of pesticides from contaminated simulated soils in packed bed are shown in Figs. 8 and 9. The figures show that the desorption efficiency of the two types of pesticides (pirimicarb and imidacloprid) were increased with increasing the flow rate of distilled washing water. This result may be due to the fact that when the flow rate increases the amount of distilled washing water increased too (i.e. the volume of water treated the same amount of contaminated soil is increased at the same unit time leading to increase the chance of transferring of the pesticide molecules from contaminated soils via the distilled washing water by desorption process). Therefore, the removal efficiency of pesticides from contaminated soils was increased with increasing the flow rate of distilled washing water.

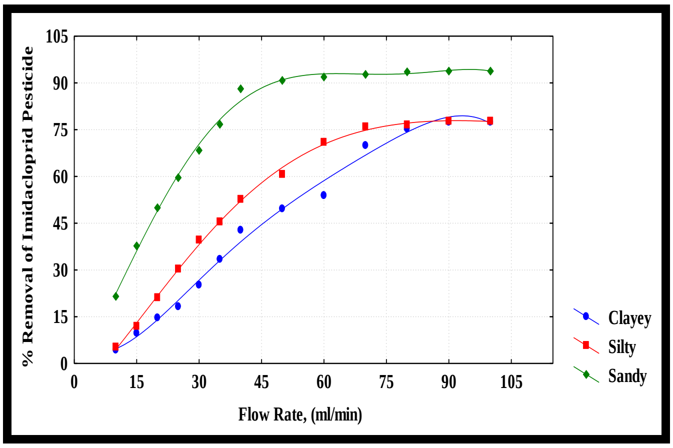

Figure 9: Effect of flow rate on the % removal of imidacloprid pesticide from three different types of Iraqi soils using distilled washing water

B. Removal of Pesticides from Polluted Washing Water

The results explained that when the adsorbent media (WP or UTL) height in second packed bed column was increased, the percentage removal of two types pesticides (pirimicarb and imidacloprid) was increased too at constant other variables as shown in Fig. 10. The increased of bed height (*l*) meaning increased in the amount of adsorbent media (WP or UTL), thus increasing the surface area of adsorbent material, hence increased the number of active sites in the adsorbent material surface (i.e. increasing the availability of binding sites for adsorption and consequently increase the pesticides removal capacity on WP or UTL). This lead to increase the ability of adsorbent media to adsorb greater amount of pirimicarb or imidacloprid pesticides at different initial concentrations of contaminated washing water and ultimately increasing the percentage removal of pesticides (pirimicarb or imidacloprid).

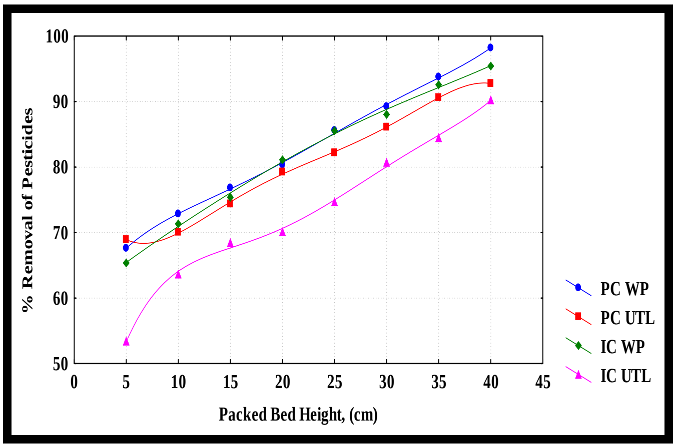

Figure 10: Influence of packed bed height on % removal of pesticides using residues. Where PC WP is pirimicarb removed by WP, PC UTL is pirimicarb removed by UTL, IC WP is imidacloprid removed by WP, and IC UTL is imidacloprid removed by UTL

The results of Fig. 11 illustrated that when the flow rate of contaminated washing water of pesticides was increased, the percentage removal of pesticides was decreased (for both pirimicarb and Imidacloprid) at constant other variables. This may be due to the fact that when the flow rate of pesticides in polluted solution was increasing, the velocity of solution in the fixed bed column packed with the adsorbent media (WP and UTL) was increasing too, so the solution spend shorter time in contact with adsorbent media than the time spent in the column, while at low flow rate, the solution of pesticides resides in the column for a longer time, and therefore undergoes more treatment with the adsorbent media (WP or UTL), thus the adsorbent media uptake more amount of pesticides from polluted solution greater than high flow rate, therefore the percentage removal of both pirimicarb and imidacloprid pesticides was decreased when the flow rate was increased.

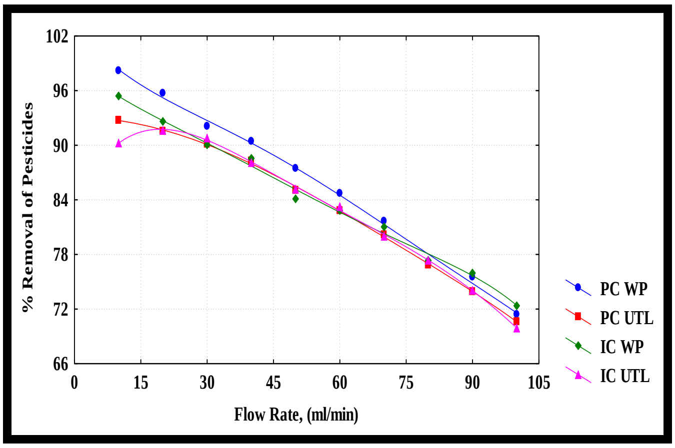

Figure 11: Influence of flow rate on % removal of pesticides using residues. Where PC WP is pirimicarb removed by WP, PC UTL is pirimicarb removed by UTL, IC WP is imidacloprid removed by WP, and IC UTL is imidacloprid removed by UTL

The results of Fig. 12 demonstrated that when the treatment time of pirimicarb and imidacloprid pesticides in contaminated washing water was increased the percentage removal of pesticides was increased too (for both pirimicarb and imidacloprid) at constant other variables. This was due to that when the treatment time of pesticides in contaminated solution was increasing and the velocity of solution in the fixed bed column packed with the adsorbent material (WP or UTL) was remaining constant, the pesticide solution spend longer time in contact with adsorbent material (WP and UTL) than that the one of treatment decreased, so the adsorbent material taken more amount of pesticides from polluted solution feed. Therefore, the percentage removal of pesticides from pesticide solution feed was increased.

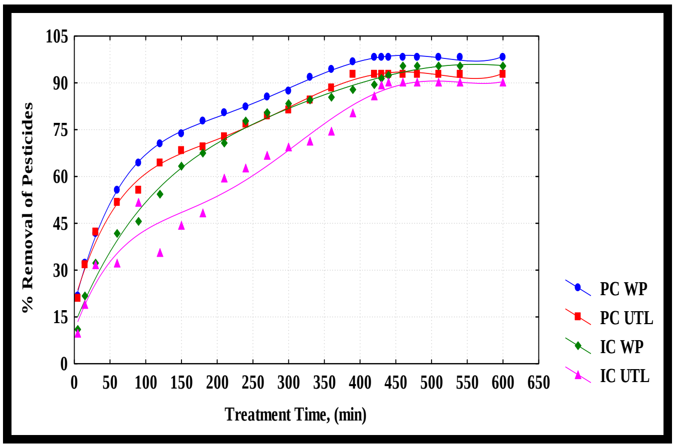

Figure 12: Influence of treatment time on % removal of pesticides using residues. Where PC WP is pirimicarb removed by WP, PC UTL is pirimicarb removed by UTL, IC WP is imidacloprid removed by WP, and IC UTL is imidacloprid removed by UTL

C. Characterization of Adsorbent Materials

Scanning Electron Microscopy (SEM) micrographs of PW and UTL surface adsorbents are represented in Figs. 13 and 14. The figures show that the two types of adsorbents present all of the cavities to the level of their surfaces. Indeed, the two kinds of pesticides (pirimicarb and imidacloprid) permit the development of the porosity of both adsorbent materials, so producing adsorbents of more open pores. The both types of adsorbents (WP and UTL) have compact structure and homogeneous surface with a developed porosity, due to micropores were observed in this materials. This may be explained the reason of three results which are firstly the graduated of increasing in the removal efficiency from low to high because these pesticides change the morphology of the adsorbents and opened another block pores which permit to another molecules of pesticides to enter (i.e. more removal). Secondly, the best results obtained always for pirimicarb than imidacloprid, and lastly why is WP better than UTL constantly.

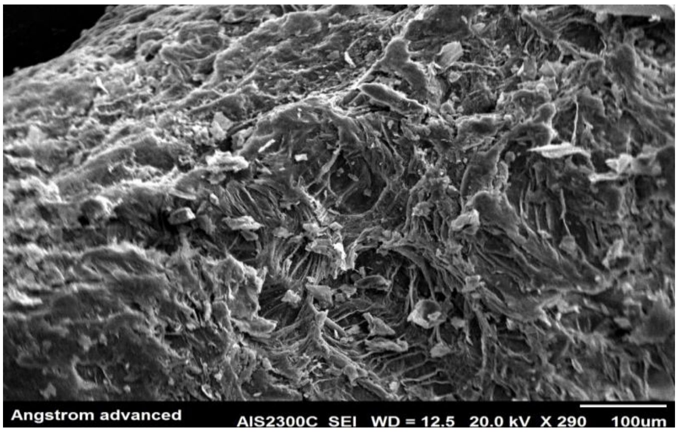

Figure 13: Scanning Electron Microscopy of WP

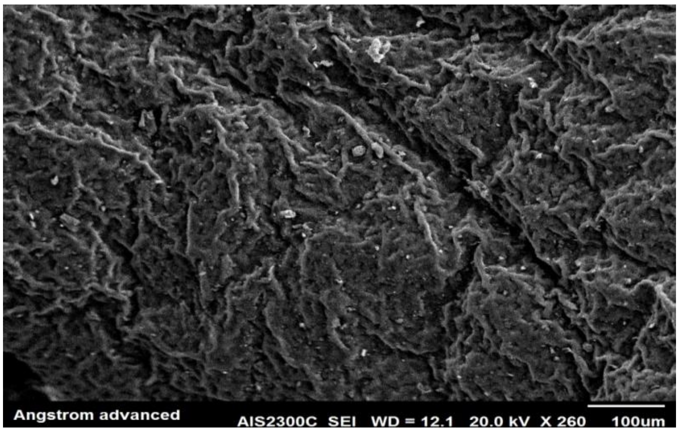

Figure 14: Scanning Electron Microscopy of UTL

The specific surface area of two types of adsorbents (WP and UTL) was determined through N_2 adsorption isotherm and the results are shown in Table II. The low value of specific surface area for both WP and UTL show that the entry of N_2 gas molecules to the existing pores in the WP and UTL are restricted and the pores are closed. In addition, these results make it possible to explain the influence of the residence time of the adsorption of the two types of pesticides (pirimicarb and imidacloprid). Longer treatment time was required to absorb the pesticides by these adsorbents. This tine of treatment is also needed to open the closed pores inside the surface of these materials (as explained above); therefore, the removal efficiency was increased with increasing the treatment time due to the increasing that occurs in specific surface area and more pores are opened. The adsorption of pesticides (i.e. impregnation) effect on porous volume also like affects the specific surface area and porosity. The higher impregnation with pesticides means slightly increases in specific surface area and porous volume for adsorbent materials after treatment with pesticides in compare with fresh adsorbent material.

TABLE II
SPECIFIC SURFACE AREA OF ADSORBENTS MATERIALS

Adsorbent material	**Specific Surface Area (m^2/g)**		
	Fresh	**After treated with pirimicarb**	**After treated with imidacloprid**
Watermelon Peels (WP)	0.98	13.79	9.19
Used Tea Leaves (UTL)	0.09	8.54	6.77

D. Benefit of Residues

After the adsorption removal process of pirimicarb and imidacloprid was ended, considerable amount of polluted WP and UTL which were used as a low cost adsorbent material are wasted. Therefore, to eschew any harmful effect for these residues on organisms or soil or water, it must be disposed or decreased their amounts to minimum in a safe, economic, beneficial, and eco-friendly method. The suggested method that may be used to dispose these toxic residues is to convert them to useful substance like rodenticide. The following method was investigated as a safe, economic, beneficial, and eco-friendly non-conventional method to get rid of the WP and UTL loaded with pirimicarb and imidacloprid pesticides.

The waste residue remaining after removal of pirimicarb and imidacloprid pesticides from polluted washing water by adsorption process using WP and UTL were collected, a prelude to prepare a simple rodenticide. Twenty groups (ten for male and ten for female) of an outbred multipurpose breed of albino rat which was Sprague dawley rat (*Rattus rattus*) shown in Fig. 15 were used in this test. Each group has ten rats besides another animal control group to compare the results. Before the test is beginning, the rats were left for one week in clean and convenient cages and nurtured with normal feed to make sure that it's were not suffer from anything leading to death. The residues which containing pirimicarb and imidacloprid pesticides were sorted according to the containing of pirimicarb and imidacloprid pesticides and mixed with little amount of waste fruit to give sweet test and feed to the rats directly as rodenticide without any further treatment. The results were fate the rats in different periods and the calculated mean lethal dosage, LD_{50}, for both types of pesticides was also calculated as shown in Table III.

Figure 15: Sprague dawley rat (*Rattus rattus*)

TABLE IIII
MEAN LETHAL DOSAGE LD_{50} (MG OF PESTICIDE/KG OF BODY RAT) OF PIRIMICARB AND IMIDACLOPRID PESTICIDES CALCULATED IN THIS STUDY

Pesticide Type	LD_{50} Calculated for male (mg/kg)	LD_{50} Calculated for female (mg/kg)	Standard LD_{50}
Pirimicarb	152	142	118-197 for Mail 121-166 for Female (Lees and Connolly, 1995)
Imidacloprid	450	430	450 (Criswell et. al., 2007)

IV. CONCLUSION

In this study, the remediation of two types of pesticides: pirimicarb and imidacloprid from three types of Iraqi soils (sandy, silty loam, and clayey) was investigated. The treatment process for the soils was carried out through washing method using distilled water in a packed bed column then; a continuous fixed bed unit was used to perform the removal of the same two types of pesticides from wasted washing polluted water using adsorption technique at different operating conditions with low-cost adsorbents which were watermelon peel (WP) and used tea leaves (UTL). The results show that the percentage removal of pirimicarb pesticide from contaminated soils was reached to 75.4% at 360 min, 86.3% at 420 min and 99.8% at 180 min for clayey, silty loam, and sandy soils, respectively, at agitation speed

=150 rpm. The percent removal of imidacloprid pesticide was reached to 71.7% at 480 min, 77.7% at 300 min and 93.3% at 240 min for clayey, silty loam, and sandy soils, respectively, at agitation speed =150 rpm.

The percentage removal of pesticides from polluted washing water using WP as an adsorbent was reached to 98.2% at 420 min for pirimicarb and 95.4% at 460 min for imidacloprid, respectively, at fixed bed height=40 cm and flowrate of polluted solution=10 ml/min. The percentage removal of pirimicarb pesticides from polluted washing water using UTL as an adsorbent was reached to 92.8% at 390 min for pirimicarb and 90.3% for imidacloprid, respectively, at fixed bed height=40 cm and flowrate of polluted solution=10 ml/min. It can be utilized from the residual samples of WP and UTL that adsorb pirimicarb and imidacloprid pesticides from polluted washing water as rodenticide for rodent control without any further treatment and get rid of these polluted materials in safe, economic, beneficial, and eco-friendly method.

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