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# Sorption/Desorption and Kinetics of Atrazine, Chlorfenvinphos, Endosulfan Sulfate and Trifluralin on Agro-Industrial and Composted Organic Wastes

**Raquel Rojas [1,2], Guillermo Repetto [1,*], José Morillo [2] and José Usero [2]**

[1] Area of Toxicology, Department of Molecular Biology and Biochemical Engineering, Universidad Pablo de Olavide, Ctra. de Utrera Km 1, 41013 Seville, Spain; rrojrod@upo.es
[2] Department of Chemical and Environmental Engineering, University of Seville, Camino de los Descubrimientos s/n, 41092 Seville, Spain; jmorillo@us.es (J.M.); usero@us.es (J.U.)
* Correspondence: grepkuh@upo.es

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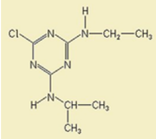
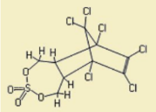
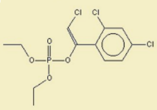
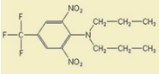
**Table S1.** physicochemical properties of the studied pesticides.

| Pesticide | Type | 2D structure diagram | Chem. Family | Chem. Formula | Molecular Weight (mol⁻¹) | $S_w$ (20 °C mg L⁻¹) | DT50 typical (days) | GUS | $K_{oc}$ (mL g⁻¹) | Log $K_{ow}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Atrazine | Herbicide |  | Triazine | $C_8H_{14}ClN_5$ | 215.68 | 35 | 75 | 3.20 | 100 | 2.75 |
| Endosulfan sulfate | Metabolite |  | Organochlorine | $C_9H_6Cl_6O_4S$ | 422.93 | 0.48 | - | - | 5194 | 3.66 |
| Chlorfenvinphos | Insecticid, Acaricide |  | Organophosfate | $C_{12}H_{14}Cl_3O_{49}$ | 359.57 | 145 | 40 | 1.87 | 680 | 3.85 |
| Trifluralin | Herbicide |  | Dinitroaniline | $C_{13}H_{16}F_3N_3O_4$ | 335.28 | 0.221 | 181 | 0.13 | 15800 | 5.27 |

Footnotes: $S_w$ (20 °C mg L⁻¹): Water solubility. DT50: typical half life. GUS: GUS indexes coefficient. $K_{oc}$: normalized organic carbon coefficient. $K_{ow}$: octanol/water coefficient. Data from PPDB (2020).

**Table S2.** Correlation coefficients between sorption-desorption and kinetic parameters and pesticides physicochemical properties ($n = 4$, $p < 0.05$).

| | Molecular Weight (mol⁻¹) | $S_w$ (20 °C mg/L) | DT50 typical(days) | GUS | $K_{oc}$ (mL/g) | Log $K_{ow}$ | Molecular Weight (mol⁻¹) | $S_w$ (20 ºC mg/L) | DT50 typical(days) | GUS | $K_{oc}$ (mL/g) | Log $K_{ow}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sorption capacity (%) (600 mg - Effect of adsorbent dose) | | | | | | $K_2$ | | | | | |
| OR1 | 0.89 | 0.44 | −0.22 | −0.64 | 0.31 | 0.57 | 0.05 | −0.45 | 0.97 | −0.48 | 0.42 | 0.68 |
| OR2 | 0.85 | −0.11 | 0.37 | −0.93 | 0.70 | 0.95 | 0.46 | −0.66 | 0.77 | −0.84 | 0.84 | 0.93 |
| OR3 | 0.88 | −0.08 | 0.31 | −0.93 | 0.70 | 0.94 | 0.48 | −0.83 | 0.58 | −0.84 | 0.96 | 0.85 |
| OR4 | 0.82 | −0.36 | 0.44 | −0.99 | 0.86 | 0.99 | 0.06 | −0.42 | 0.97 | −0.49 | 0.41 | 0.68 |
| | $K_i$ | | | | | | $X_i$ | | | | | |
| OR1 | 0.14 | 0.85 | −0.90 | 0.38 | −0.55 | −0.52 | 0.89 | −0.01 | 0.27 | −0.91 | 0.65 | 0.91 |
| OR2 | −0.53 | 0.79 | −0.58 | 0.87 | −0.96 | −0.89 | 0.83 | −0.27 | 0.42 | −0.97 | 0.81 | 0.99 |
| OR3 | 0.06 | 1.00 | −0.61 | 0.40 | −0.69 | −0.44 | 0.80 | −0.37 | 0.46 | −0.98 | 0.86 | 1.00 |
| OR4 | 0.28 | 0.81 | −0.91 | 0.24 | −0.42 | −0.40 | 0.67 | −0.50 | 0.62 | −0.95 | 0.87 | 0.99 |
| | $N_{fa}$ | | | | | | $K_{fa}$ | | | | | |
| OR1 | 0.04 | −0.93 | 0.80 | −0.53 | 0.73 | 0.62 | 0.76 | −0.62 | 0.27 | −0.94 | 0.99 | 0.88 |
| OR2 | 0.60 | 0.61 | 0.04 | −0.41 | 0.00 | 0.45 | 0.36 | −0.83 | 0.74 | −0.78 | 0.88 | 0.84 |
| OR3 | 0.72 | −0.59 | 0.48 | −0.97 | 0.96 | 0.97 | 0.42 | −0.63 | 0.81 | −0.81 | 0.79 | 0.91 |
| OR4 | 0.92 | −0.07 | 0.23 | −0.94 | 0.72 | 0.92 | 0.32 | −0.70 | 0.85 | −0.75 | 0.77 | 0.86 |
| | $K_d$ | | | | | | $K_{oc}$ | | | | | |
| OR1 | 0.50 | −0.75 | 0.67 | −0.87 | 0.92 | 0.91 | 0.50 | −0.75 | 0.67 | −0.87 | 0.92 | 0.91 |
| OR2 | 0.32 | −0.64 | 0.87 | −0.74 | 0.73 | 0.87 | 0.32 | −0.64 | 0.87 | −0.74 | 0.73 | 0.87 |
| OR3 | 0.24 | −0.57 | 0.92 | −0.67 | 0.63 | 0.82 | 0.24 | −0.57 | 0.92 | −0.67 | 0.63 | 0.82 |
| OR4 | 0.25 | −0.57 | 0.92 | −0.67 | 0.63 | 0.82 | 0.25 | −0.57 | 0.92 | −0.67 | 0.63 | 0.82 |
| | $N_{fd}$ | | | | | | $K_{fd}$ | | | | | |
| OR1 | 0.27 | 0.97 | −0.50 | 0.16 | −0.52 | −0.19 | | −0.88 | 0.75 | −0.71 | 0.85 | 0.77 |
| OR2 | 0.56 | −0.21 | −0.85 | −0.26 | 0.43 | 0.02 | 0.46 | −0.76 | 0.87 | −0.72 | 0.59 | 0.87 |
| OR3 | 0.68 | −0.36 | −0.76 | −0.41 | 0.56 | 0.17 | 0.63 | −0.88 | 0.75 | −0.85 | 0.74 | 0.95 |
| OR4 | −0.62 | 0.87 | −0.76 | 0.84 | −0.73 | −0.95 | 0.75 | −0.94 | 0.63 | −0.92 | 0.84 | 0.99 |
| | H | | | | | | %D | | | | | |
| OR1 | −0.33 | −0.91 | 0.76 | −0.17 | 0.45 | 0.28 | 0.05 | 1.00 | −0.60 | 0.40 | −0.70 | −0.43 |
| OR2 | −0.06 | −0.31 | 1.00 | −0.26 | 0.08 | 0.49 | −0.37 | 0.86 | −0.68 | 0.78 | −0.91 | −0.82 |
| OR3 | −0.17 | −0.21 | 0.99 | −0.16 | −0.02 | 0.39 | 0.31 | 0.95 | −0.64 | 0.16 | −0.49 | −0.23 |
| OR4 | 0.28 | −0.62 | 0.95 | −0.58 | 0.42 | 0.76 | −0.20 | 0.95 | −0.67 | 0.64 | −0.85 | −0.68 |

Footnotes: $S_w$ (Water solubility), DT50 (half-life), GUS (GUS indexes coefficient), $K_{oc}$ (normalized organic carbon coefficient) and $K_{ow}$ (octanol/water coefficient), were taken from PPDB (2020).

**Table S3.** Determination coefficients between sorption-desorption and kinetic parameters and physicochemical properties of organic wastes ($p < 0.05$).

| | %TOC | BET | pH | C | N | O | Na | Mg | Al | Si | P | S | Cl | K | Ca | Ti | Fe | Cu | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *n* | 4 | 4 | 4 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 1 | 2 | 1 | *n* |
| | Sorption capacity (%) (600 mg - Effect of adsorbent dose) | | | | | | | | | | | | | | | | | | |
| AT | 0.52 | −0.47 | −0.92 | **0.95** | n/a | −0.20 | n/a | −0.39 | n/a | −0.01 | n/a | n/a | −0.52 | 0.49 | −0.52 | n/a | n/a | n/a | 4 |
| TF | −0.46 | 0.40 | 0.89 | −0.93 | n/a | 0.27 | n/a | 0.04 | n/a | −0.34 | n/a | n/a | 0.18 | −0.15 | 0.19 | n/a | n/a | n/a | 4 |
| CF | 0.78 | −0.87 | **−0.97** | **0.95** | n/a | 0.36 | n/a | −0.99 | n/a | −0.87 | n/a | 1.00 | **−1.00** | **1.00** | **−1.00** | n/a | n/a | n/a | 4 |
| ES | 0.03 | 0.33 | 0.75 | −0.62 | n/a | 0.20 | n/a | 0.05 | n/a | −0.33 | n/a | n/a | 0.20 | −0.17 | 0.20 | n/a | n/a | n/a | 4 |
| | $Q_e$ exp | | | | | | | | | | | | | | | | | | |
| AT | 0.42 | −0.51 | −0.94 | 0.92 | n/a | −0.14 | n/a | −0.35 | n/a | 0.03 | n/a | n/a | −0.48 | 0.46 | −0.49 | n/a | n/a | n/a | 4 |
| TF | −0.24 | 0.38 | 0.87 | −0.83 | n/a | 0.26 | n/a | 0.03 | n/a | −0.35 | n/a | n/a | 0.18 | −0.15 | 0.18 | n/a | n/a | n/a | 4 |
| CF | 0.86 | −0.83 | −0.94 | **0.96** | n/a | 0.32 | n/a | −0.99 | n/a | −0.97 | n/a | n/a | −0.96 | 0.96 | −0.95 | n/a | n/a | n/a | 4 |
| ES | 0.19 | 0.30 | 0.63 | −0.46 | n/a | 0.12 | n/a | 0.09 | n/a | −0.30 | n/a | n/a | 0.23 | −0.20 | 0.24 | n/a | n/a | n/a | 4 |
| | $K_2$ | | | | | | | | | | | | | | | | | | |
| AT | 0.86 | −0.84 | −0.42 | 0.43 | n/a | 0.84 | n/a | −0.88 | n/a | **−1.00** | n/a | n/a | −0.81 | 0.83 | ** | n/a | n/a | n/a | 4 |
| TF | 0.66 | **−0.96** | −0.89 | 0.79 | n/a | 0.60 | n/a | −0.96 | n/a | −0.78 | n/a | n/a | −0.99 | 0.98 | −0.99 | n/a | n/a | n/a | 4 |
| CF | 0.52 | −0.71 | −0.10 | 0.02 | n/a | **0.98** | n/a | −0.95 | n/a | **−1.00** | n/a | n/a | −0.90 | 0.91 | −0.90 | n/a | n/a | n/a | 4 |
| ES | 0.67 | −0.49 | −0.90 | **0.98** | n/a | −0.15 | n/a | −0.95 | n/a | **−1.00** | n/a | n/a | −0.90 | 0.91 | −0.90 | n/a | n/a | n/a | 4 |
| | $K_i$ | | | | | | | | | | | | | | | | | | |
| AT | **−0.98** | 0.83 | 0.62 | −0.68 | n/a | −0.62 | n/a | 0.83 | n/a | 0.98 | n/a | n/a | 0.74 | −0.76 | 0.74 | n/a | n/a | n/a | 4 |
| TF | −0.10 | −0.56 | −0.56 | 0.31 | n/a | 0.36 | n/a | −0.50 | n/a | −0.13 | n/a | n/a | −0.62 | 0.60 | −0.62 | n/a | n/a | n/a | 4 |
| CF | −0.50 | 0.91 | 0.87 | −0.72 | n/a | −0.55 | n/a | 0.87 | n/a | 0.62 | n/a | n/a | 0.93 | −0.92 | 0.93 | n/a | n/a | n/a | 4 |
| ES | −0.33 | 0.88 | 0.61 | −0.40 | n/a | −0.77 | n/a | 0.88 | n/a | 0.64 | n/a | n/a | 0.94 | −0.93 | 0.94 | n/a | n/a | n/a | 4 |
| | $X_i$ | | | | | | | | | | | | | | | | | | |
| AT | 0.91 | −0.90 | −0.88 | 0.89 | n/a | 0.49 | n/a | −0.97 | n/a | −0.99 | n/a | n/a | −0.93 | 0.94 | −0.93 | n/a | n/a | n/a | 4 |
| TF | −0.02 | −0.21 | 0.46 | −0.56 | n/a | 0.78 | n/a | −0.95 | n/a | **−1.00** | n/a | n/a | −0.90 | 0.91 | −0.89 | n/a | n/a | n/a | 4 |
| CF | 0.62 | −0.89 | **−0.96** | 0.86 | n/a | 0.43 | n/a | −0.90 | n/a | −0.67 | n/a | n/a | −0.96 | 0.95 | −0.96 | n/a | n/a | n/a | 4 |
| ES | 0.44 | −0.87 | −0.38 | 0.21 | n/a | **0.96** | n/a | −0.99 | n/a | −0.87 | n/a | n/a | **−1.00** | **1.00** | **−1.00** | n/a | n/a | n/a | 4 |
| | $n_{fa}$ | | | | | | | | | | | | | | | | | | |
| AT | 0.03 | −0.51 | −0.77 | 0.60 | n/a | 0.06 | n/a | −0.33 | n/a | 0.05 | n/a | n/a | −0.47 | 0.44 | −0.47 | n/a | n/a | n/a | 4 |
| TF | −0.27 | −0.21 | −0.56 | 0.39 | n/a | −0.19 | n/a | 0.00 | n/a | 0.38 | n/a | n/a | −0.14 | 0.11 | −0.15 | n/a | n/a | n/a | 4 |
| CF | −0.77 | 0.17 | 0.09 | −0.31 | n/a | −0.12 | n/a | 0.13 | n/a | 0.50 | n/a | n/a | −0.02 | −0.01 | −0.02 | n/a | n/a | n/a | 4 |
| ES | −0.35 | −0.18 | −0.49 | 0.30 | n/a | −0.16 | n/a | −0.01 | n/a | 0.37 | n/a | n/a | −0.15 | 0.13 | −0.16 | n/a | n/a | n/a | 4 |
| | $K_{fa}$ | | | | | | | | | | | | | | | | | | |
| AT | −0.28 | 0.73 | 0.88 | −0.71 | n/a | −0.28 | n/a | 0.62 | n/a | 0.27 | n/a | n/a | 0.72 | −0.70 | 0.73 | n/a | n/a | n/a | 4 |
| TF | 0.09 | 0.29 | 0.71 | −0.58 | n/a | 0.22 | n/a | 0.01 | n/a | −0.37 | n/a | n/a | 0.15 | −0.12 | 0.16 | n/a | n/a | n/a | 4 |
| CF | 0.34 | 0.14 | 0.50 | −0.33 | n/a | 0.24 | n/a | −0.07 | n/a | −0.44 | n/a | n/a | 0.07 | −0.05 | 0.08 | n/a | n/a | n/a | 4 |
| ES | 0.22 | 0.24 | 0.61 | −0.45 | n/a | 0.20 | n/a | 0.00 | n/a | −0.38 | n/a | n/a | 0.14 | −0.12 | 0.15 | n/a | n/a | n/a | 4 |
| | $K_d$ | | | | | | | | | | | | | | | | | | |
| AT | 0.43 | −0.50 | −0.94 | 0.92 | n/a | −0.16 | n/a | −0.34 | n/a | 0.05 | n/a | n/a | −0.47 | 0.44 | −0.47 | n/a | n/a | n/a | 4 |
| TF | −0.04 | 0.37 | 0.79 | −0.68 | n/a | 0.19 | n/a | 0.08 | n/a | −0.30 | n/a | n/a | 0.22 | −0.20 | 0.23 | n/a | n/a | n/a | 4 |
| CF | −0.17 | 0.65 | 0.84 | −0.66 | n/a | −0.20 | n/a | 0.51 | n/a | 0.14 | n/a | n/a | 0.63 | −0.61 | 0.63 | n/a | n/a | n/a | 4 |
| ES | 0.12 | 0.35 | 0.68 | −0.51 | n/a | 0.09 | n/a | 0.14 | n/a | −0.25 | n/a | n/a | 0.28 | −0.25 | 0.29 | n/a | n/a | n/a | 4 |
| | $K_{oc}$ | | | | | | | | | | | | | | | | | | |
| AT | −0.74 | 0.09 | 0.24 | −0.49 | n/a | 0.15 | n/a | −0.10 | n/a | 0.29 | n/a | n/a | −0.24 | 0.21 | −0.25 | n/a | n/a | n/a | 4 |
| TF | −0.25 | 0.42 | 0.88 | −0.83 | n/a | 0.22 | n/a | 0.11 | n/a | −0.28 | n/a | n/a | 0.25 | −0.22 | 0.26 | n/a | n/a | n/a | 4 |
| CF | −0.49 | 0.70 | **0.98** | −0.92 | n/a | −0.10 | n/a | 0.69 | n/a | 0.36 | n/a | n/a | 0.78 | −0.77 | 0.79 | n/a | n/a | n/a | 4 |
| ES | −0.45 | 0.47 | 0.93 | −0.93 | n/a | 0.19 | n/a | 0.29 | n/a | −0.09 | n/a | n/a | 0.43 | −0.40 | 0.43 | n/a | n/a | n/a | 4 |
| | $n_{fd}$ | | | | | | | | | | | | | | | | | | |
| AT | −0.49 | 0.60 | −0.04 | 0.09 | n/a | −0.94 | n/a | 0.90 | n/a | **1.00** | n/a | n/a | 0.83 | −0.85 | 0.83 | n/a | n/a | n/a | 4 |
| TF | 0.20 | −0.36 | −0.85 | 0.81 | n/a | −0.27 | n/a | 0.00 | n/a | 0.38 | n/a | n/a | −0.14 | 0.11 | −0.15 | n/a | n/a | n/a | 4 |
| CF | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 2 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ES | −0.27 | −0.21 | −0.57 | 0.39 | n/a | −0.19 | n/a | 0.00 | n/a | 0.38 | n/a | n/a | −0.14 | 0.11 | −0.15 | n/a | n/a | n/a | 4 |
| | $K_{fd}$ | | | | | | | | | | | | | | | | | | |
| AT | 0.75 | **−0.96** | −0.57 | 0.49 | n/a | 0.90 | n/a | −0.99 | n/a | −0.96 | n/a | n/a | −0.96 | 0.97 | −0.96 | n/a | n/a | n/a | 4 |
| TF | −0.19 | 0.37 | 0.85 | −0.80 | n/a | 0.26 | n/a | 0.01 | n/a | −0.37 | n/a | n/a | 0.15 | −0.12 | 0.16 | n/a | n/a | n/a | 4 |
| CF | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 2 |
| ES | 0.16 | 0.38 | 0.64 | −0.45 | n/a | 0.01 | n/a | 0.20 | n/a | −0.19 | n/a | n/a | 0.34 | −0.31 | 0.34 | n/a | n/a | n/a | 4 |
| | H | | | | | | | | | | | | | | | | | | |
| AT | 0.55 | −0.71 | −0.10 | 0.03 | n/a | **0.98** | n/a | −0.95 | n/a | **−1.00** | n/a | n/a | −0.89 | 0.90 | −0.89 | n/a | n/a | n/a | 4 |
| TF | 0.01 | 0.30 | 0.76 | −0.65 | n/a | 0.25 | n/a | −0.01 | n/a | −0.39 | n/a | n/a | 0.13 | −0.10 | 0.14 | n/a | n/a | n/a | 4 |
| CF | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 2 |
| ES | −0.06 | 0.55 | 0.79 | −0.61 | n/a | −0.10 | n/a | 0.38 | n/a | 0.00 | n/a | n/a | 0.51 | −0.48 | 0.51 | n/a | n/a | n/a | 4 |
| | %D | | | | | | | | | | | | | | | | | | |
| AT | −0.91 | 0.65 | 0.31 | −0.41 | n/a | −0.65 | n/a | 0.68 | n/a | 0.91 | n/a | n/a | 0.57 | −0.59 | 0.56 | n/a | n/a | n/a | 4 |
| TF | 0.22 | −0.37 | −0.86 | 0.82 | n/a | −0.27 | n/a | 0.00 | n/a | 0.38 | n/a | n/a | −0.14 | 0.12 | −0.15 | n/a | n/a | n/a | 4 |
| CF | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 2 |
| ES | 0.03 | −0.69 | −0.55 | 0.30 | n/a | 0.56 | n/a | −0.67 | n/a | −0.34 | n/a | n/a | −0.77 | 0.75 | −0.78 | n/a | n/a | n/a | 4 |

Footnotes: AT: Atrazine, TF: Trifluralin, CF: chlorfenvinphos, ES: endosulfan sulfate. Kinetic parameters: $Q_e$ exp (quantity of pesticide adsorbed at equilibrium), $K_2$ (Ho and McKay rate constants), $K_i$ (intraparticle diffusion rate constant), $X_i$ (Morris-Weber constant, proportional to the boundary layer thickness). Sorption constants: $n_{fa}$ (Freundlich coefficient correlated to adsorption intensity), $K_{fa}$ (Freundlich constant correlated to the maximum multilayer adsorption capacity). $K_d$ (lineal sorption constant, calculated for one sorption concentration (200 μg $L^{-1}$)), $K_{oc}$ (normalized organic carbon coefficient, calculated as ($K_d$/%COT) · 100, where $K_d = Q_e/C_e$), $n_{fd}$ (Freundlich coefficient correlated to desorption intensity) Desorption constants: $K_{fd}$ (Freundlich constant correlated to the maximum multilayer desorption capacity), H (hysteresis coefficient), %D (desorption percentages). In bold: significant correlations.

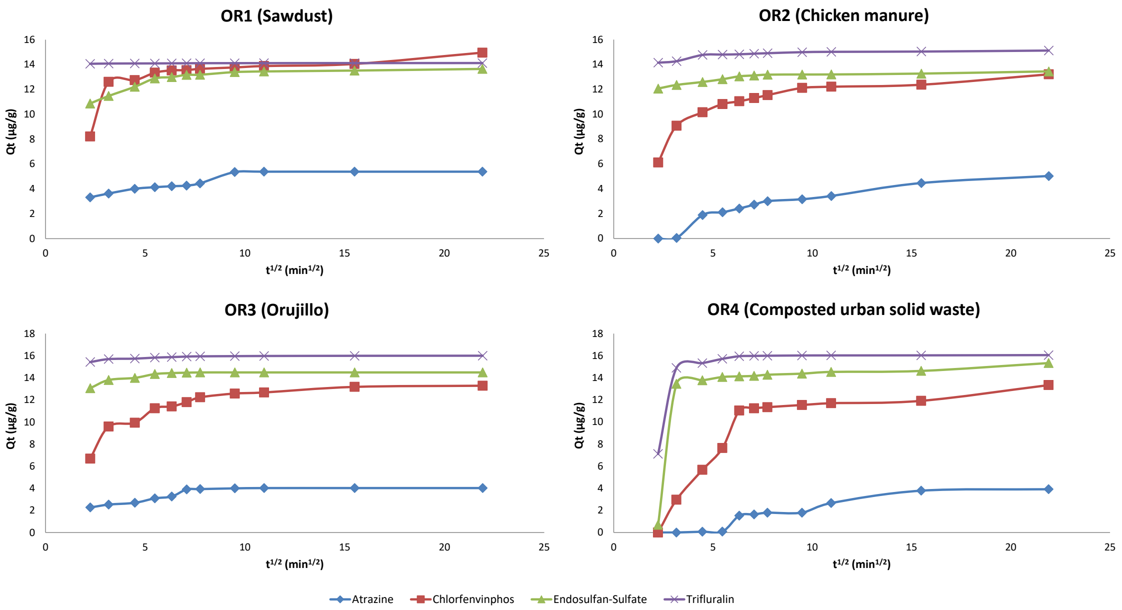



**Figure S1.** Weber-Morris intraparticle diffusion model of each studied adsorbent for the different pesticides.

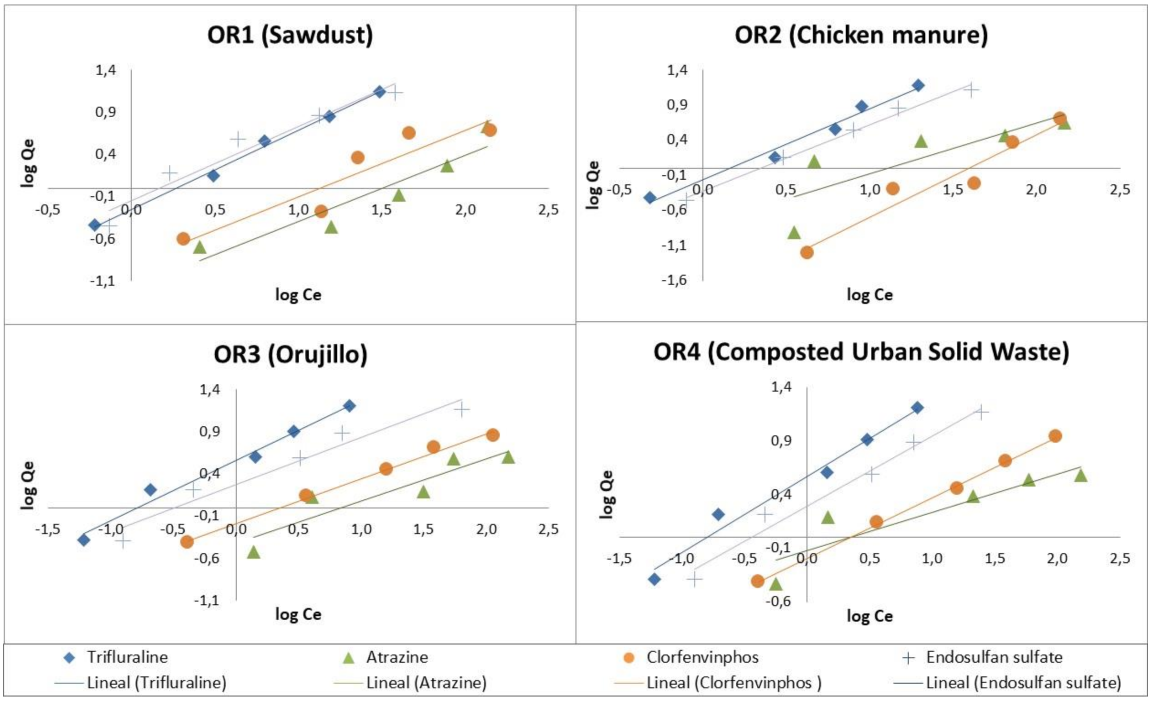



**Figure S2.** Freundlich sorption isotherms of all pesticides on each organic residue.

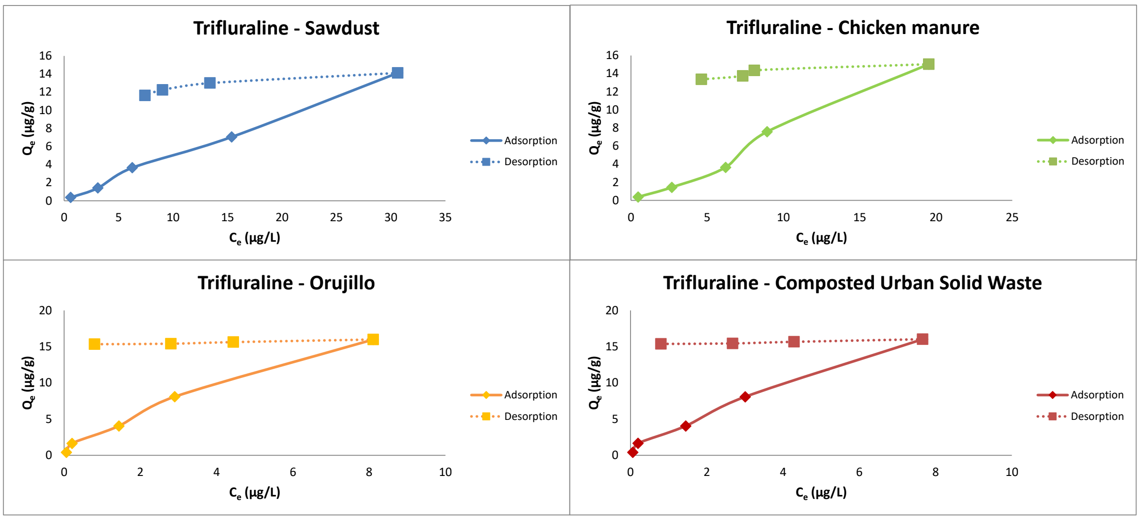



**Figure S3.** Sorption - desorption isotherms trifluralin on each organic residue.

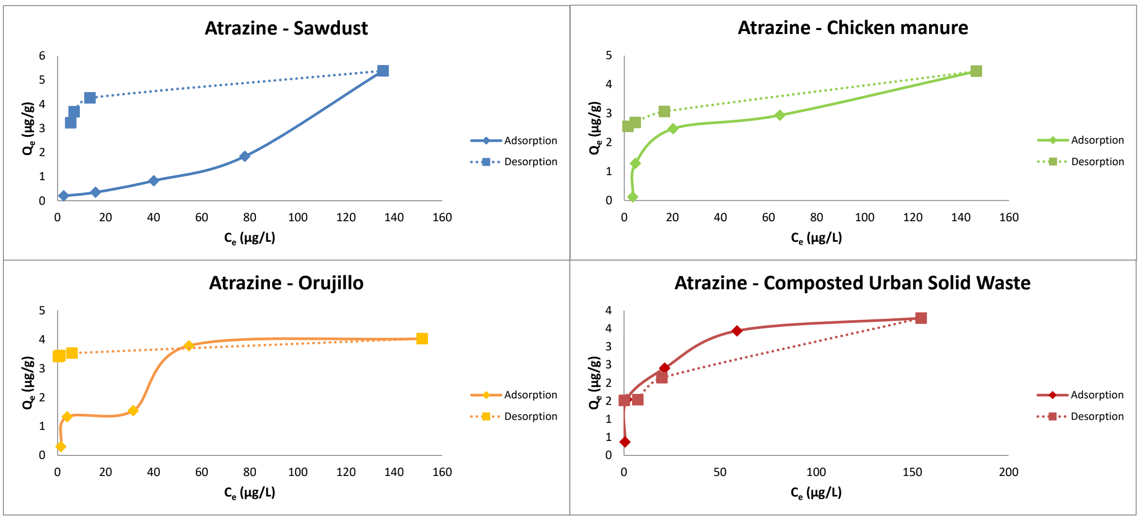



**Figure S4.** Sorption - desorption isotherms atrazine on each organic residue.

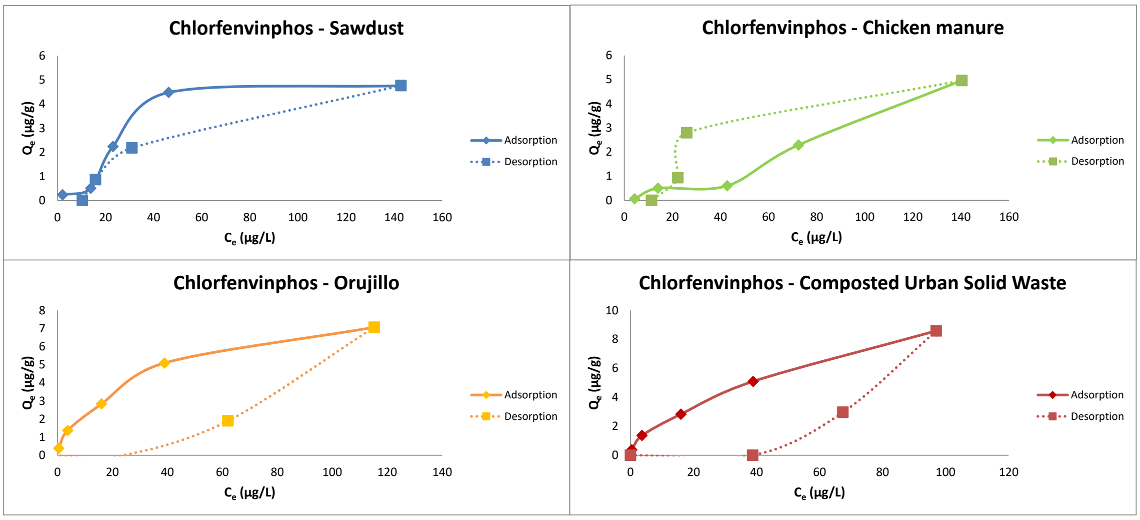



**Figure S5.** Sorption - desorption isotherms chlorfenvinphos on each organic residue.

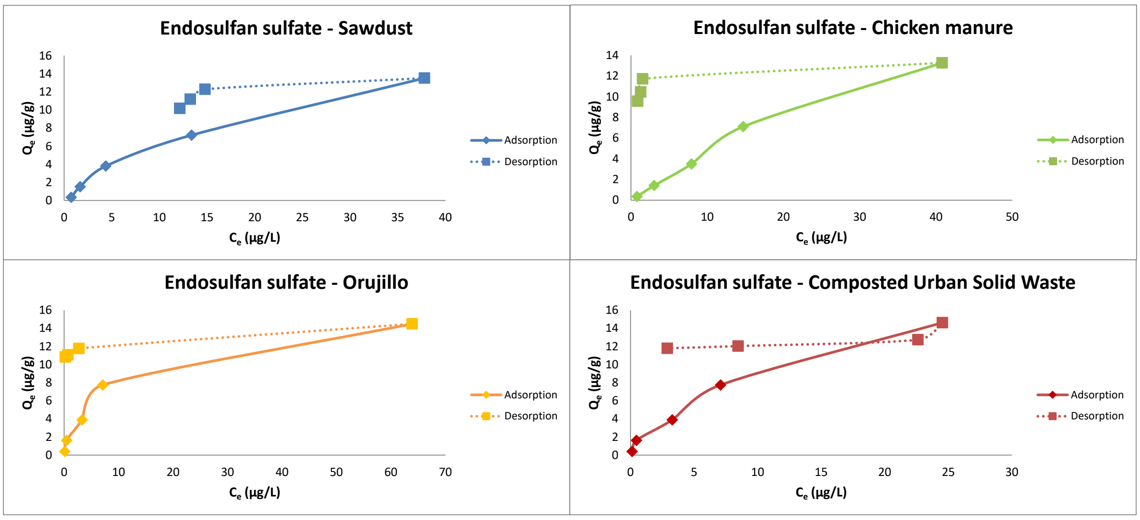



**Figure S6.** Sorption - desorption isotherms endosulfan sulfate on each organic residue.