SUPPLEMENTARY MATERIAL

1. Characterization technique

Different types of instrumentation technique used for characterization of synthesized nanoparticles and degradation studies, Powder X-ray diffraction (PXRD) by (Panalytical Xpert Pro), Fourier Transform-Infrared Spectrophotometer (Perkin Elmer), Field Emission Scanning Electron Microscope (Nova Nano FE-SEM 450 (FEI)) of gold coated samples with Energy Dispersive X-ray Spectroscopy (EDS), and X-ray Photoelectron Spectroscopy (ESCA+ omicron nanotechnology). UV Spectrophotometer (Agilent Carry 100), Zeta Potential (Nano ZSP (ZEN 5600)), and CPA-225D Sartius Analytical balance were used for weighing purposes, and LABWAN –PH-61WW instruments were used for the preparation of pH solutions.

Table 1S. Details of angle, FWHM values, interplanar spacing and hkl values of Ag@$ZnCr_2O_4$ $ZnCr_2O_4$ and ZnO respectively.

Angle (2θ)	**FWHM values**	**d-spacing (A^0)**	**hkl values**
31.8778	0.2676	2.80737	(220)
34.6340	0.4684	2.59001	(300)
36.4163	0.3680	2.46723	(311)
38.2526	0.1338	2.35291	(222)
44.5226	0.4015	2.03504	(400)
47.6154	0.2234	1.85543	(422)
56.7488	0.5353	1.62224	(511)
62.8820	0.8029	1.47797	(440)

Angle (2θ)	**FWHM values**	**d-spacing (A^0)**	**hkl values**
30.30°	0.2676	2.78988	(220)
33.85°,	0.4015	2.58166	(300)
35.72°,	0.2007	2.45783	(311)
43.40°	0.5353	2.01410	(400)

47.89°	0.2032	1.84679	(422)
56.85	0.2676	1.61934	(511)
65.40	0.4015	1.42695	(440)

Angle (2θ)	**FWHM values**	**d-spacing (A^0)**	**hkl values**
31.98	0.23	2.795	(100)
34.63	0.20	2.587	(002)
36.47	0.24	2.461	(101)
47.73	0.27	1.903	(200)
56.59	0.31	1.619	(110)
63.04	0.32	1.473	(103)
68.11	0.36	1.375	(112)

2. Details of Langmuir, Freundlich, Temkin, Sip and D-R isotherms used in present study

Adsorption data through Langmuir adsorption isotherms were calculated through graph of Ce/qe v/s Ce of the solute. Which were calculated by fitting the adsorption data into the equation:

$$\frac{C_e}{q_e} = \frac{1}{k_L X_m} + \frac{C_e}{X_m}$$

or

$$\frac{1}{qe} = \frac{1}{C_e}\left(\frac{1}{k_L X_m}\right) + \frac{1}{X_m}$$

qe was calculated through the equation:

$$qe = \frac{(Ci - Ce) \times Volofsolution(mL) \times Molecularweightofadsorbent}{Amountofcatalyst\ (mg)}$$

2.1Fruendlich Isotherm

A typical graph of Qe v/s Ce of the solute was a straight line. $Qe = Kf + Ce1/n$ and linear form is $$\log Xe = \log Kf + \frac{1}{n} logCe$$

Where C_e is the equilibrium concentration of the dye solution; Qe is the amount of dye adsorbed per gram weight of adsorbent; Kf is the Freundlich adsorption constant (mg/g); n is adsorption intensity.

2.2 Temkin Isotherm

$$qe = \frac{RT}{b} \ln A + \frac{RT}{b} \ln Ce$$

Where B=RT/b constant related to heat of sorption (J/mol) obtained from the Temkin plot (qeVslnCe); A (slope) = Temkin isotherm equilibrium binding constant (L/g); b (intercept) = Temkin isotherm constant; R =universal gas constant (8.314 J·mol−1·K−1) T = Temperature at 298, 308 and 318 K.

As $D_e$values were very low, the und$_e$rvalues were coming out to be negative. Therefore, Temkin isotherm (Qe v/s lnC_e) was not plotted for present study

2.3 Dubinin-Radushkevich (D-R) isotherm

$$\ln qe = \ln Xm - \beta\varepsilon 2$$

$$\varepsilon = RTln\left(1 + \frac{1}{Ce}\right)$$

Where X_m is maximum adsorption capacity (mg/g) obtained from intercept; β (mol^2/J^2) is a activity coefficient constant related to sorption energy and obtained from slop;ε is Polanyi potential. D-R was plotted between lnqe Vs ε^2

2.4 Sips Isotherm

It is plotted between 1/Qe $\times 10^{-2}$ (g/mg) and (1/Ce) $\times 10^{-8}$ L/mg; where (1/mg) and (mg/g) are the Sips equilibrium constant and maximum adsorption capacity values obtained from the slope and the intercept of the plot. The Sips isotherm equation is characterized by the dimensionless heterogeneity factor 'n' which can also be employed to describe the system's heterogeneity when is between 0 and 1.

$$\frac{1}{q_e} = \frac{1}{XmKs}\left(\frac{1}{Ce}\right)1/n + \frac{1}{X_m}$$

Table 2S. Details of Langmuir, Freundlich, Temkin, Sip and D-R isotherms

	Langmuir						**Freundlich**					
	ES			MB			ES			MB		
Catalyst	k	$t_{1/2}$	R^2	k	$t_{1/2}$	R^2	k	$t_{1/2}$	R^2	k	$t_{1/2}$	R^2
Ag@$ZnCr_2O_4$	0.26	2.68	0.98	0.19	3.64	.978	0.82	0.84	0.99	0.73	0.94	0.99
$ZnCr_2O_4$	0.19	3.64	0.98	0.10	6.93	0.98	0.70	0.99	0.99	0.63	1.1	0.98
ZnO	0.08	8.66	0.96	0.09	7.7	0.99	0.65	1.06	0,98	0.47	1.47	0.97
Blank	0.01	69.3	0.99	0.02	34.65	0.998	0.62	1.11	0.99	0.12	5.772	0.99

	Sip						D-R					
	ES			MB			ES			MB		
Catalyst	k	$t_{1/2}$	R^2	k	$t_{1/2}$	R^2	k	$t_{1/2}$	R^2	k	$t_{1/2}$	R^2
Ag@$ZnCr_2O_4$	0.26	2.66	0.98	0.28	2.45	0.978	0.82	0.84	0.99	0.89	0.77	0.99
$ZnCr_2O_4$	0.19	3.64	0.98	0.23	3.01	0.98	0.70	0.99	0.99	0.76	0.91	0.98
ZnO	0.05	13.86	0.96	0.04	16.2	0.996	0.62	1.11	0.97	0.59	1.16	0.97
Blank	0.01	69.3	0.99	0.02	34.65	0.998	0.45	1.54	0.99	0.49	1.41	0.99

Table 3S. Reduced chi square, Adjusted R square and p-values of kinetics model for ES and MB pesticides.

	Ag@$ZnCr_2O_4$			**$ZnCr_2O_4$**			**ZnO**			**Blank**		
Pesticide	**Adj. R^2**	**Red. Chi^2**	**P-value**	**Adj. R^2**	**Red. Chi^2**	**P-value**	**Adj. R^2**	**Red. Chi^2**	**P-value**	**Adj. R^2**	**Red. Chi^2**	**P-value**
ES	0.99836	3.7693E-6	8.41E-05	0.96775	2.4266E-11	0.002462	0.94392	7.0832E-10	0.001609	0.9993	8.3082E-9	0.000128

MB	0.95982	1.96866E-8	0.001482	0.96946	2.1036E-11	0.001482	0.93206	1.9832E-11	0.004958	0.99147	3.2354E-10	0.000518

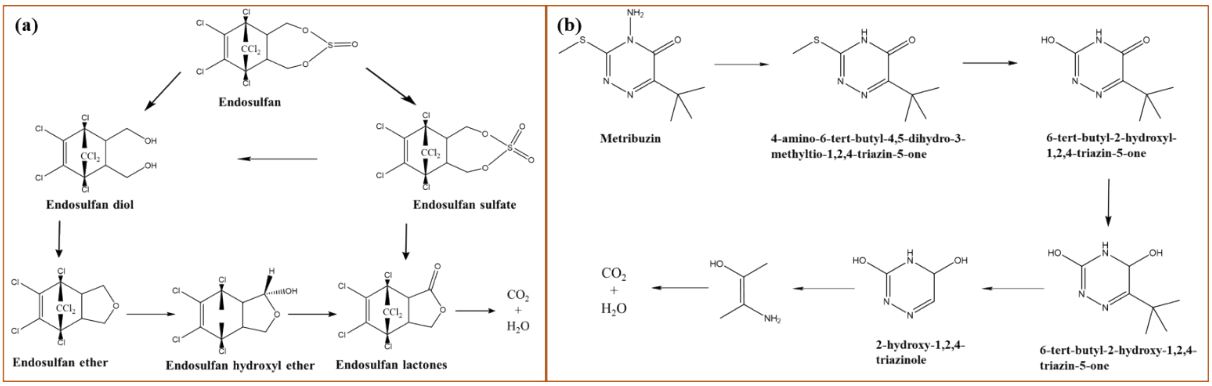

Fig 1S Proposed degradation pathway for the degradation of (a) ES and (b) MB pesticides over $Ag@ZnCr_2O_4$ nanocomposite

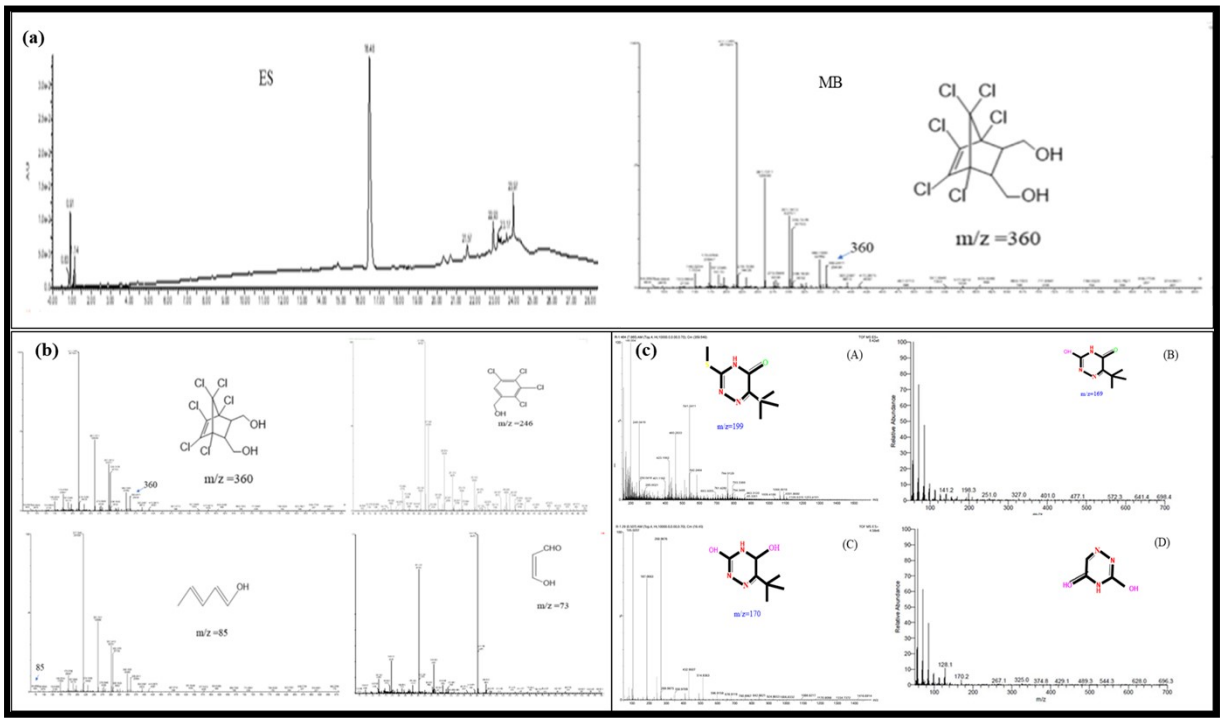

Fig 2S (a) Total ion chromatograph (TIC) of ES and MB (b) Mass spectra of MB pesticide (c) Mass spectra of ES pesticide.

4. Turn over frequency (TOF)

As we know that TOF of catalysts determines their efficiency, i.e. higher the TOF more efficient is the catalyst. TOF value can be calculated with the help of following formula:

$$\text{TOF} = \frac{No\ of\ moles\ of\ reactant/No\ of\ grams\ of\ photocatalysts}{Time\ (min)} X\ yield$$

No. of gram of photocatalyst: 0.02 g. (10ppm)

Table 4S. TOF of $Ag@ZnCr_2O_4$, $ZnCr_2O_4$ and ZnO for ES and MB pollutants

S.No.	Photocatalyst	TOF (mol min^{-1} g^{-1})	
		ES	**MB**
1.	$Ag@ZnCr_2O_4$	9.42×10^{-6}	17.49×10^{-6}
2.	$ZnCr_2O_4$	6.98×10^{-6}	12.76×10^{-6}
3.	ZnO	4.83×10^{-6}	8.65×10^{-6}

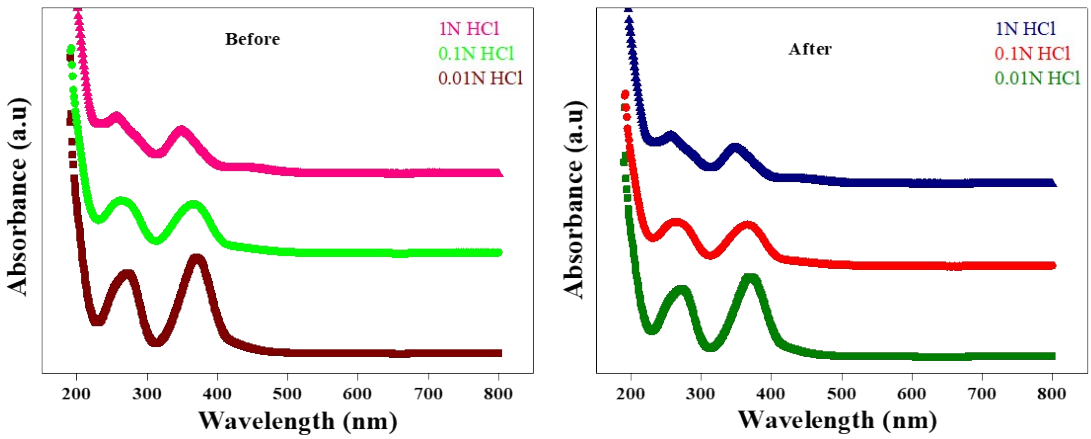

Fig 3S. UV-vis analysis of leaching solution before and after leaching in 72 h