

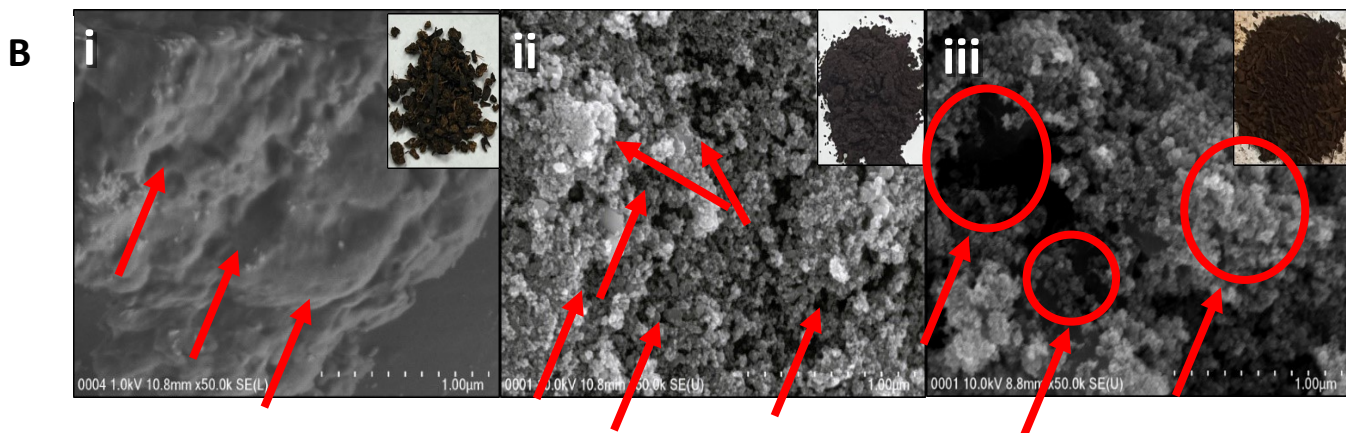
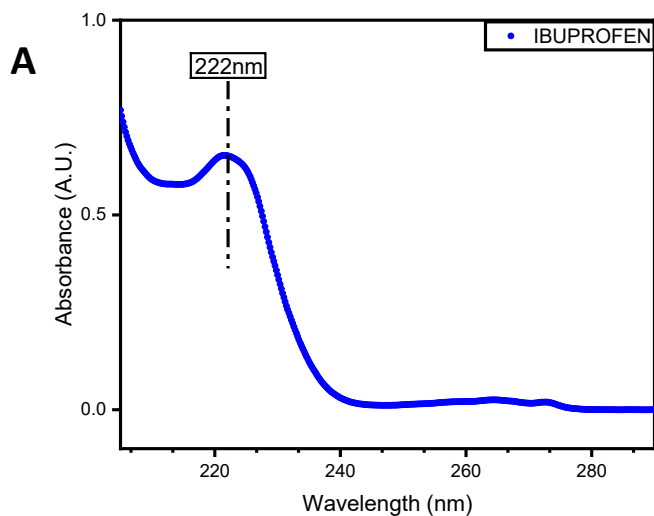
**Green and Efficient Magnetic Micro-Solid Phase Extraction Utilizing Tea-waste Impregnated with Magnetic Nanoparticles for the Analysis of Ibuprofen (IBP) in Water Samples by using UV-Vis Spectrophotometry**

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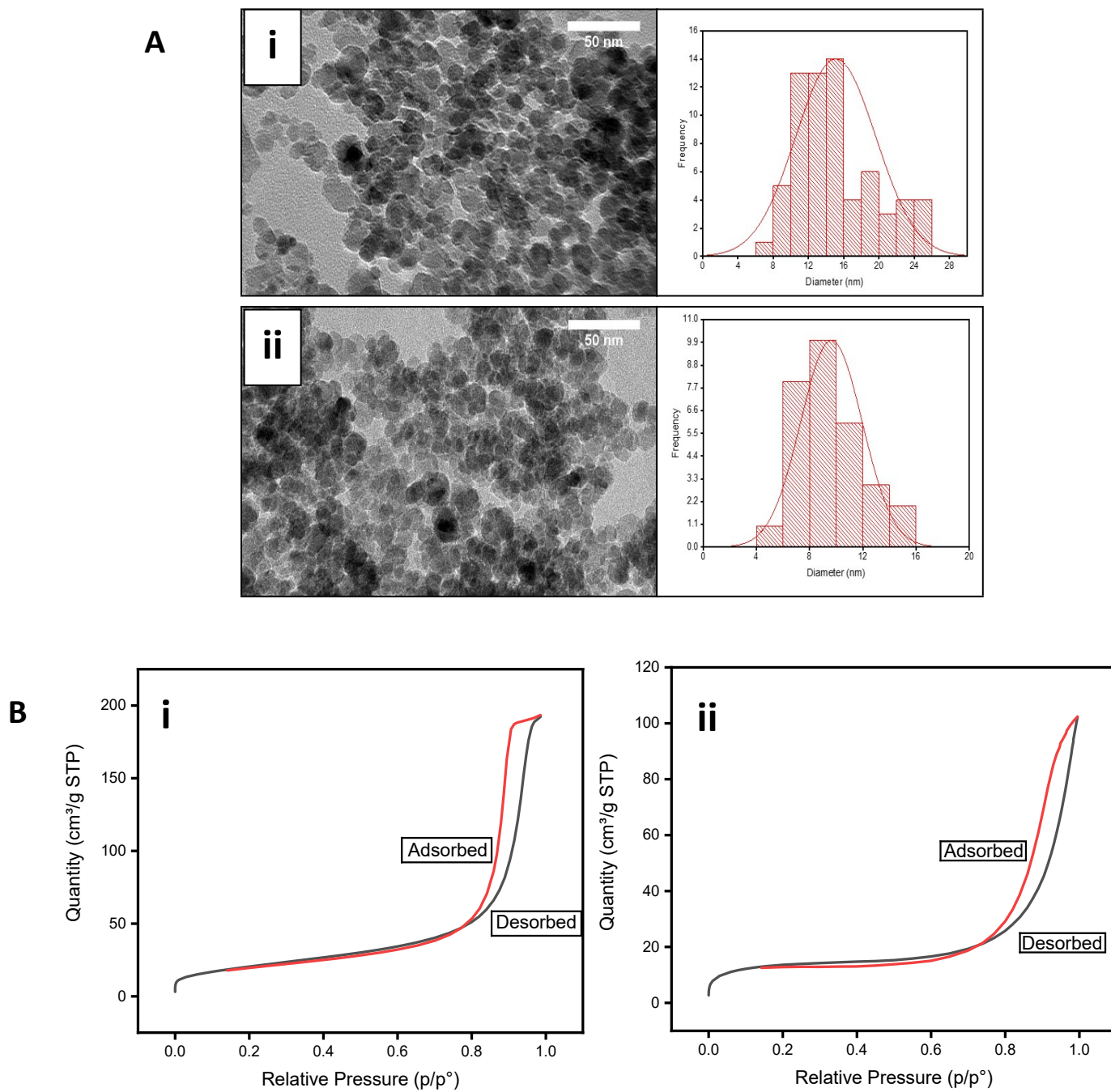
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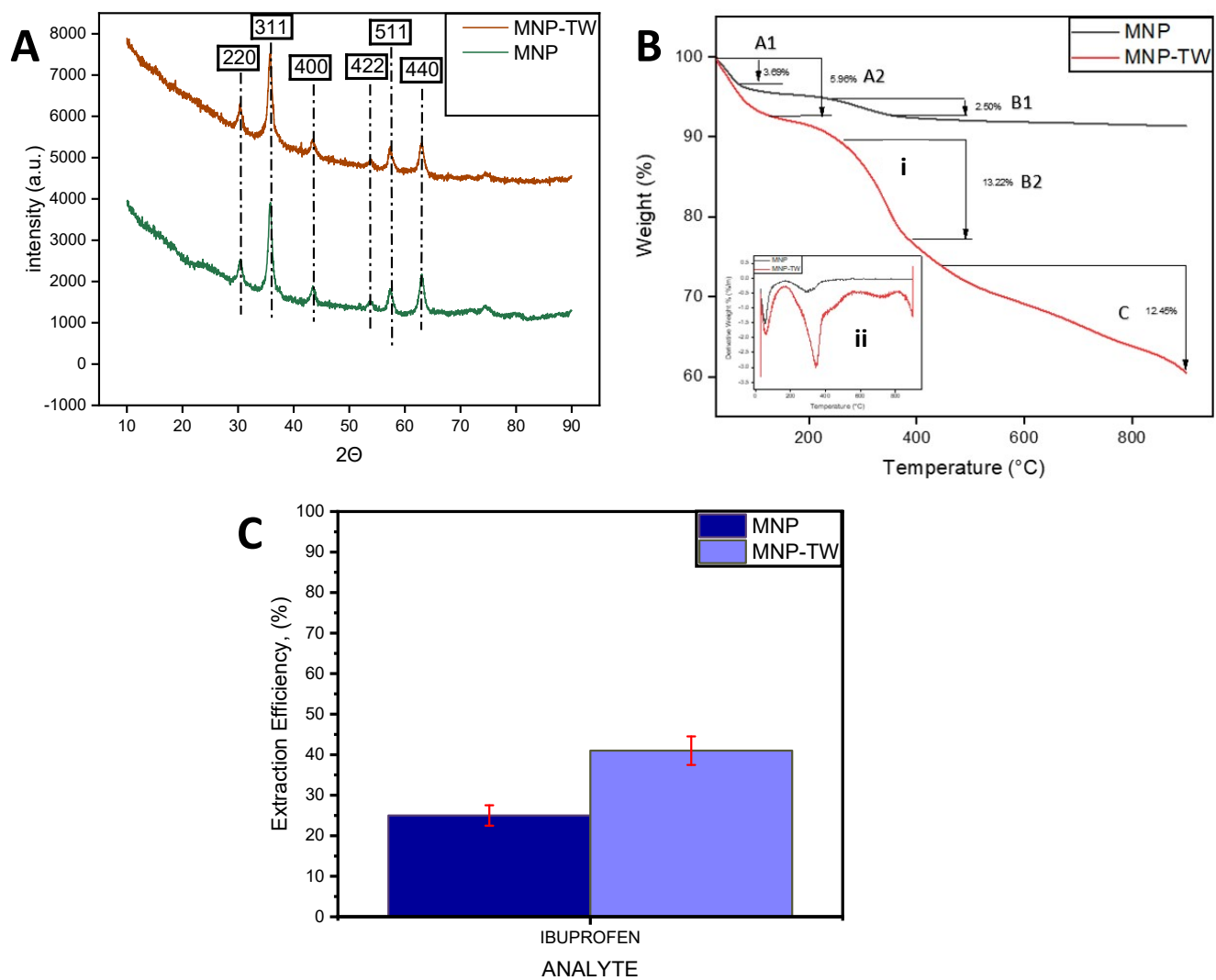
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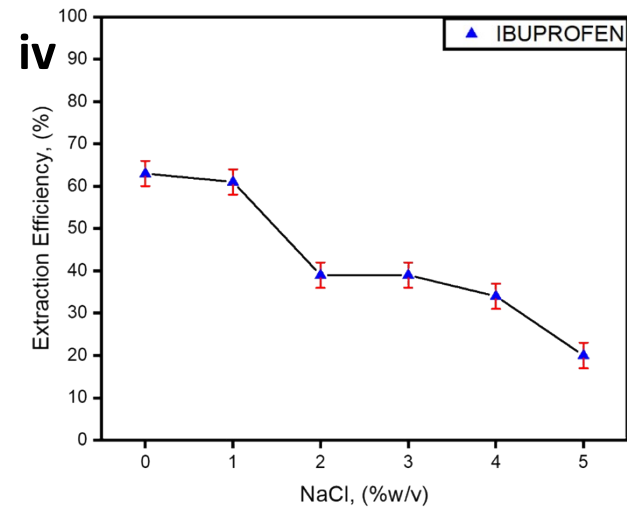
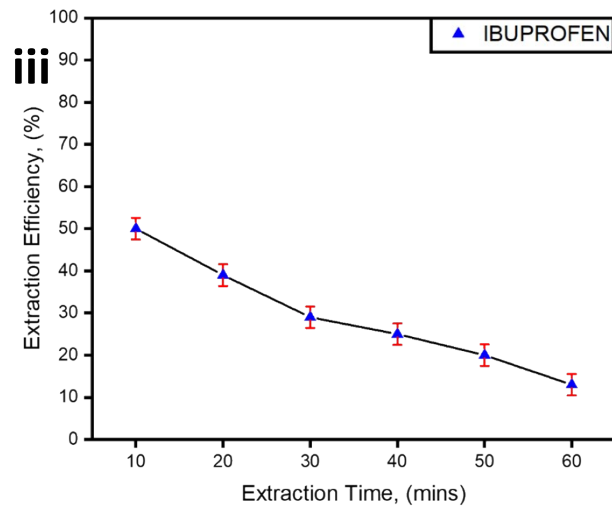
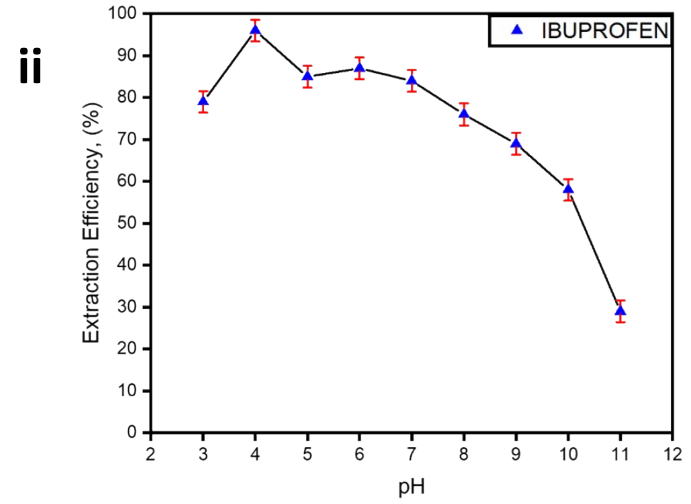
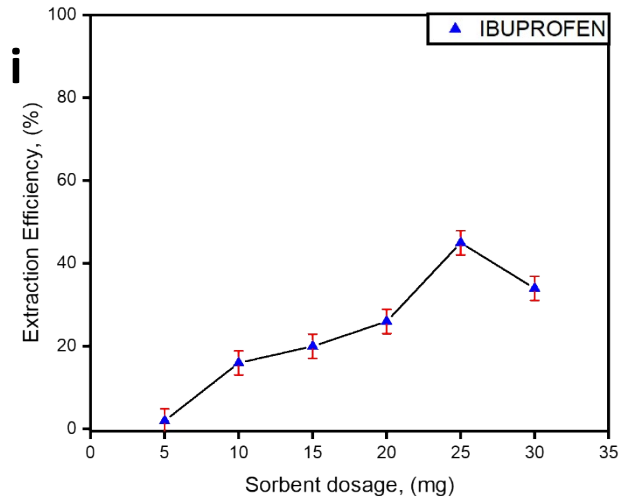
**Figure S1:** (A) The absorption of the UV-Vis spectra for IBP species at the 222nm absorption wavelength. (B) FESEM analysis of 50kx magnification: (i) TW, (ii) MNP, (iii) MNP-TW, inset: photographs of TW, MNP and MNP-TW

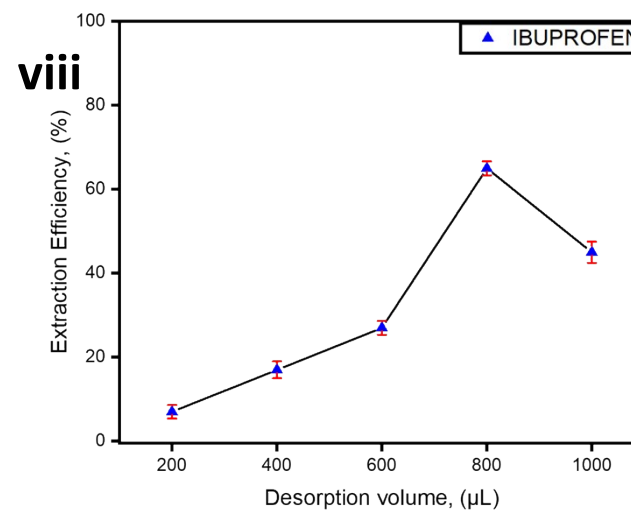
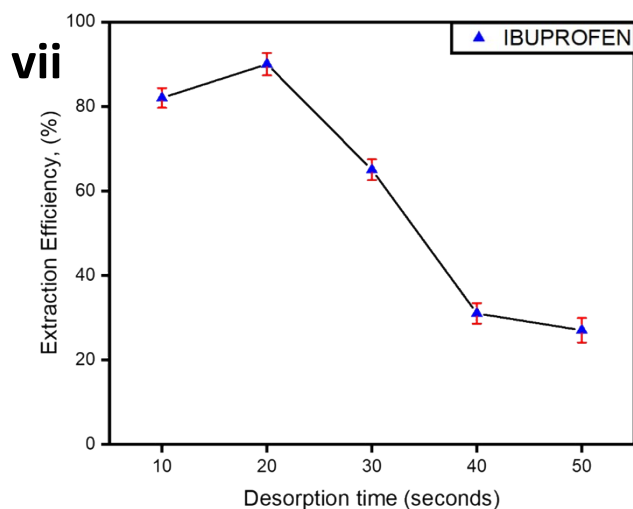
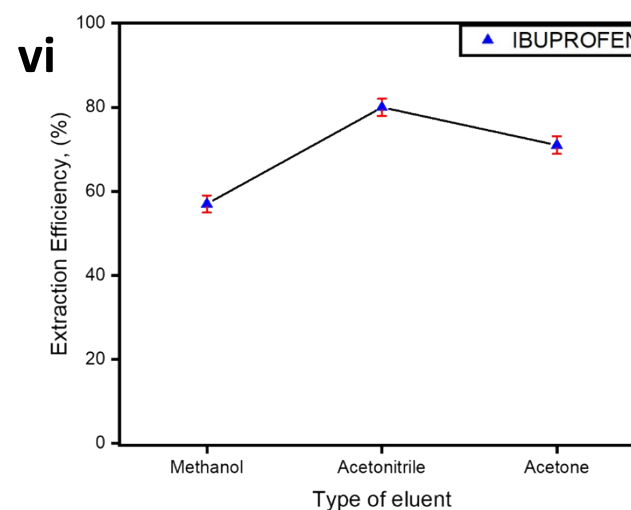
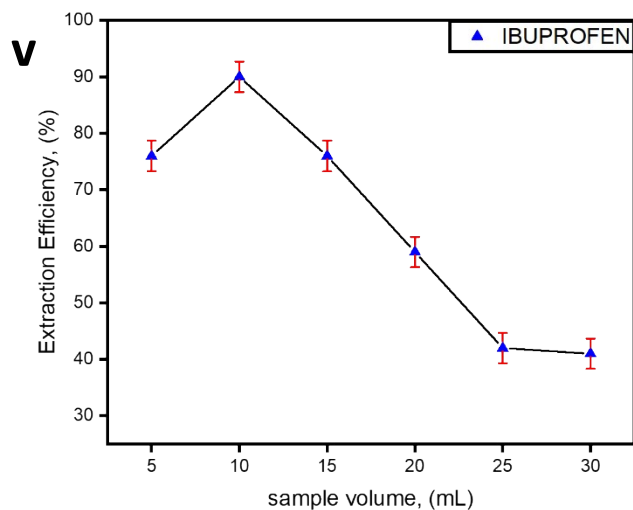


**Figure S2:**(A) TEM images of 50 nm scale image and corresponding particle diameter distributions of (i) MNP and (ii) MNP-TW. (B) BET Hysteresis loop of (i) MNP and (ii) MNP-TW

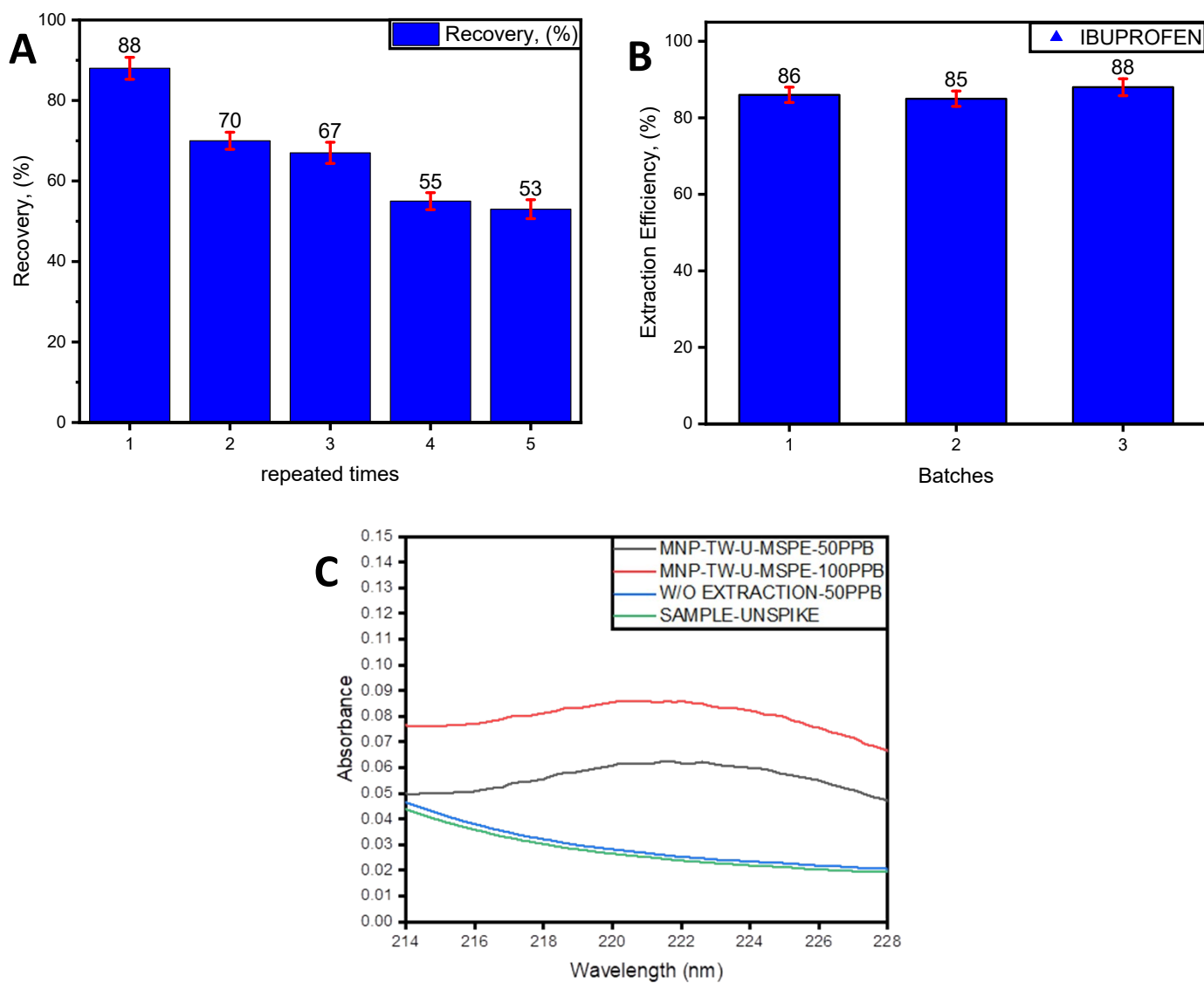


**Figure S3:** (A) XRD patterns of MNP and MNP-TW. (B) (i) TGA analysis (ii) DTA diagram of MNP and MNP-TW. (C) The extraction efficiency of MNP and MNP-TW.





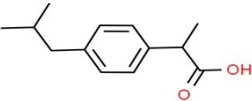
**Figure S4(i):** Effect of the sorbent dosage, **(ii):** Effect of pH, **(iii):** Effect of extraction time, **(iv):** Effect of ionic strength, **(v):** Effect of sample volume, **(vi):** Effect of desorption solvent, **(vii):** Effect of desorption time, **(viii):** Effect of desorption volume of MNP-TW on the magnetic micro-solid phase extraction efficiency of IBP (n=3)



**Figure S5:** (A) The reusability analysis of MNP-TW. (B) MNP-TW reproducibility study. (C) Typical UV-Vis spectra of IBP in water sample using MNP-TW- $\mu$ -SPE.

## List of Tables

**Table S1:** Properties of Ibuprofen.

Molecular structure	
Name	Ibuprofen
pK <sub>a</sub>	4.52
Log Kow	3.50
Molecular weight (g mol <sup>-1</sup> )	206.3
Chemical Formula	C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>

**Table S2:** BET results

Characteristics	MNP	MNP-TW
Surface area (m <sup>2</sup> /g)	67.14	48.38
Pore volume (cm <sup>3</sup> /g)	0.30	0.16
N <sub>2</sub> adsorption/desorption isotherm	Type IV	Type II
Hysteresis type loop	H1	H3
BJH pore diameter (nm)	13.09	17.83

**Table S3:** TGA analysis of MNP and MNP-TW

Adsorbents	Region	Temperature (°C)	Weight loss (%)	Assignment	Total weight loss (%)
MNP	A1	36.38 – 108.29	3.69	Water/ moisture loss	6.19
	B1	226.12 – 369.95	2.50	Volatile fractions	
MNP-TW	A2	30.75 – 98.98	5.96	Water/ moisture loss	31.63
	B2	229.81 – 380.99	13.22	Cellulose, hemicellulose, volatile fractions.	
	C	463.95 – 898.66	12.45	Devolatilization of thermally stable volatile compounds, oxidation of carbon, degradation of lignin	



**Table S4:** Optimum conditions for the extraction of IBP by MNP-TW- $\mu$ -SPE technique

<b>Parameter</b>	<b>Ibuprofen</b>
Dosage of sorbent	25 mg
pH	4
Extraction time	10 minutes
Ionic Strength	0% (No NaCl added)
Type of eluent	ACN
Desorption time	20 seconds
Desorption volume	800 $\mu$ L
Volume of sample	10 mL

**Table S5:** Analytical performance values of the developed MNP-TW- $\mu$ -SPE procedure in water sample matrices

<b>Water</b>	<b>Ibuprofen (222 nm)</b>
linearity ( $\mu$ g L <sup>-1</sup> )	30 - 700
( $R^2$ )	0.9983
LOD ( $\mu$ g L <sup>-1</sup> )	9.40
LOQ ( $\mu$ g L <sup>-1</sup> )	28.50
Intra-day, (N=3) RSD (%) at 300 $\mu$ g L <sup>-1</sup>	1.48
Inter-day, (N=3) RSD (%) at 300 $\mu$ g L <sup>-1</sup>	1.53
Pre-concentration factor at 300 $\mu$ g L <sup>-1</sup>	116

**Table S6:** Addition-Recoveries for IBP extracted from spiked water samples (n= 3).

Analyte	Samples	Correlation of determination, R <sup>2</sup>	Spiking (µg L <sup>-1</sup> )	Mean Recovery (%) (%RSD, n=3)
Ibuprofen (222 nm)	Tap water	0.9980	100	94 (1.01)
			400	98 (1.71)
			700	113 (0.84)
	Effluent water		100	89 (4.54)
			400	86 (3.95)
			700	115 (1.06)

**Table S7:** Interference study

NSAIDs combinations	Mean Recovery (%) (%RSD, n=3)		
	100 µg L <sup>-1</sup>	400 µg L <sup>-1</sup>	700 µg L <sup>-1</sup>
IBP	100 (3.8)	100 (0.5)	99 (0.1)
IBP + DCF	99 (3.1)	101 (0.8)	101 (0.2)
IBP + NAP	104 (2.5)	99 (0.5)	99 (0.4)
IBP + DCF + NAP	104 (2.3)	102 (0.5)	99 (0.4)

**Table S8:** AES scores of the MNP-TW-µ-SPE method

Reagents	Penalty points
Ammonia (25%) 5 mL	6
Solvents	6
	∑ 12
Instruments	Penalty points
UV-Vis Spectrophotometer	0
Stirrer	2
Orbital shaker	2
Occupational Hazard	3
Waste	5
	∑ 12
Total penalty points: 24	
<b>AES Total score: (100-24) = 76</b>	

