Supplementary Material (ESI) for Analytical Methods
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Electronic Supplementary Information

A simple and fast Fe_3O_4 magnetic nanoparticles-based dispersion solid phase extraction of Sudan dyes from food and water samples coupled with high-performance liquid chromatography

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Table S1. Recoveries of Sudan dyes in the presence of foreign species (Sudan I-IV concentration: 5 μg L^{-1}, 5 μg L^{-1}, 20 μg L^{-1}, 40 μg L^{-1}).

co-existing ions	at concentration	recovery (%)[a]			
		sudan I	sudan II	sudan III	sudan IV
Na^+	100 mg L^{-1}	86.62±2.21	90.72±2.21	94.83±3.43	95.88±3.15
Ca^{2+}	50 mg L^{-1}	84.25±1.87	91.65±2.32	99.77±2.18	96.75±4.02
Mg^{2+}	50 mg L^{-1}	84.32±2.84	90.57±2.00	97.39±1.29	94.88±2.66
NH_4^+	2 mg L^{-1}	83.23±1.99	91.28±2.22	94.88±1.11	92.49±1.95
SO_4^{2-}	100 mg L^{-1}	83.67±5.69	91.27±2.29	91.01±1.49	91.66±2.38
NO_3^-	50 mg L^{-1}	85.16±4.46	90.65±3.31	100.05±0.74	93.73±1.64
PO_4^{3-}	30 mg L^{-1}	80.77±1.01	82.03±1.65	97.16±2.15	94.15±2.04
CO_3^{2-}	30 mg L^{-1}	85.00±1.99	93.39±1.42	95.19±3.28	101.42±2.07
Al^{3+}	100 μg L^{-1}	90.31±1.02	96.98±1.39	101.59±1.16	101.07±2.31
Pb^{2+}	100 μg L^{-1}	86.34±1.96	93.77±1.82	102.96±1.63	98.16±1.84
Mn^{2+}	20 μg L^{-1}	90.10±1.69	96.10±1.89	101.22±1.55	98.81±2.69
Zn^{2+}	100 μg L^{-1}	83.56±1.87	87.63±2.76	93.01±5.27	93.20±1.43
Cu^{2+}	50 μg L^{-1}	81.36±4.00	91.35±1.94	99.93±1.21	96.92±1.72
Fe^{3+}	50 μg L^{-1}	83.08±0.88	93.31±1.01	99.17±2.91	95.92±1.94

[a] Mean value±standard deviation (n=3).

Table S2. Reproducibility of the Fe_3O_4 MNPs as SPE adsorbent for extraction of Sudan dyes from water samples.

targets	concentration level (μg L^{-1})	RSD (%) (for single batch)[a]			RSD (%) (among batches)[a]
		batch 1	batch 2	batch 3	
sudan I	5	3.1	0.7	2.0	2.5
sudan II	5	2.2	1.8	3.9	3.2
sudan III	20	2.1	2.4	1.9	3.4
sudan IV	40	3.6	2.7	2.4	4.6

[a] Averages of three determinations.

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Table S3. Analytical performance of the proposed method for Sudan dyes.

	water media				chili oil				chili powder				tomato paste			
targets	linear range ($\mu g\ L^{-1}$)	r^2	RSD%[a]	LOD ($\mu g\ L^{-1}$)	linear range ($\mu g\ g^{-1}$)	r^2	RSD%[b]	LOD ($\mu g\ g^{-1}$)	linear range ($\mu g\ g^{-1}$)	r^2	RSD%[b]	LOD ($\mu g\ g^{-1}$)	linear range ($\mu g\ g^{-1}$)	r^2	RSD%[b]	LOD ($\mu g\ g^{-1}$)
Sudan I	0.05–25	0.9982	2.47	0.02	0.05–10	0.9978	3.11	0.01	0.05–10	0.9958	3.58	0.01	0.05–10	0.9961	2.53	0.01
Sudan II	0.05–25	0.9983	3.15	0.02	0.05–10	0.9987	2.52	0.01	0.05–10	0.9975	2.74	0.01	0.05–10	0.9970	1.89	0.01
Sudan III	0.10–100	0.9989	3.36	0.02	0.05–40	0.9973	2.64	0.01	0.05–40	0.9989	2.06	0.01	0.05–40	0.9999	2.36	0.01
Sudan IV	0.20–200	0.9974	4.97	0.04	0.10–80	0.9981	1.97	0.02	0.10–80	0.9992	2.31	0.02	0.10–80	1	3.02	0.02

[a]Six replicate determinations of 5 $\mu g\ L^{-1}$ Sudan I, 5 $\mu g\ L^{-1}$ Sudan II, 20 $\mu g\ L^{-1}$ Sudan III and 40 $\mu g\ L^{-1}$ Sudan IV standard.

[b]Six replicate determinations of 1 $\mu g\ g^{-1}$ Sudan I, 1 $\mu g\ g^{-1}$ Sudan II, 4 $\mu g\ g^{-1}$ Sudan III and 8 $\mu g\ g^{-1}$ Sudan IV spiked foodstuff samples.

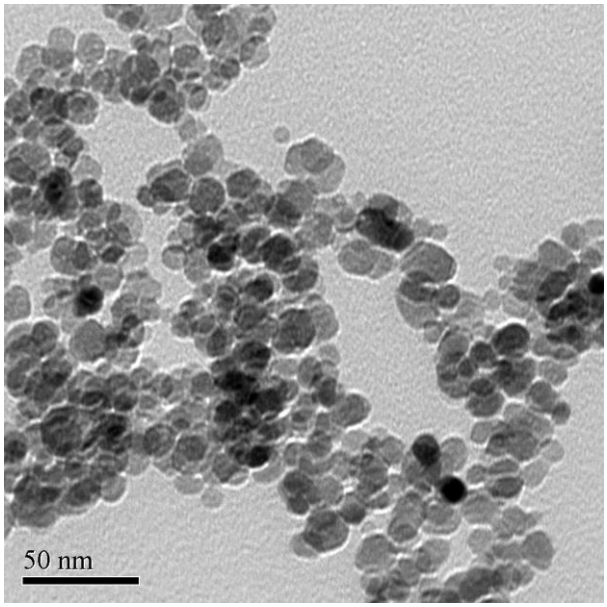

Figure S1. TEM image of the Fe_3O_4 MNPs.

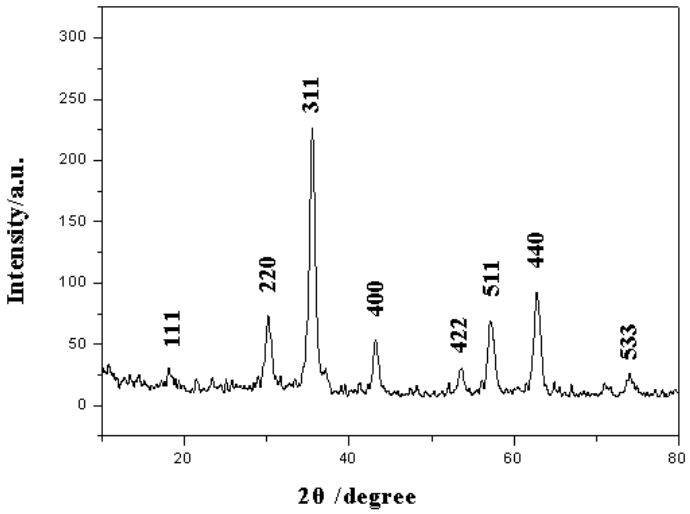

Figure S2. XRD pattern of the Fe_3O_4 MNPs.

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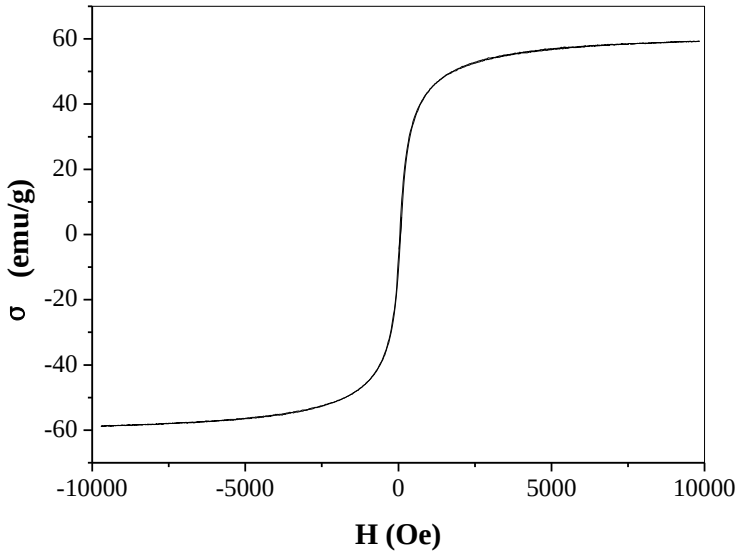

Figure S3. VSM magnetization curve of the Fe_3O_4 MNPs.

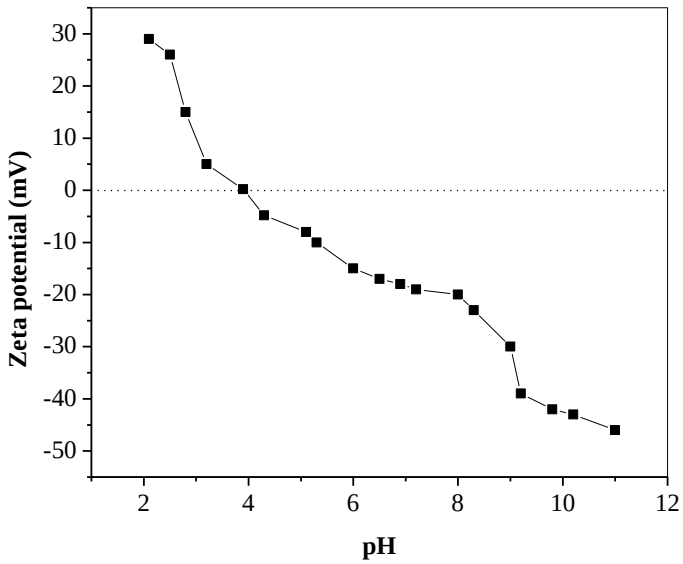

Figure S4. The zeta potentials of the as-prepared Fe_3O_4 MNPs.

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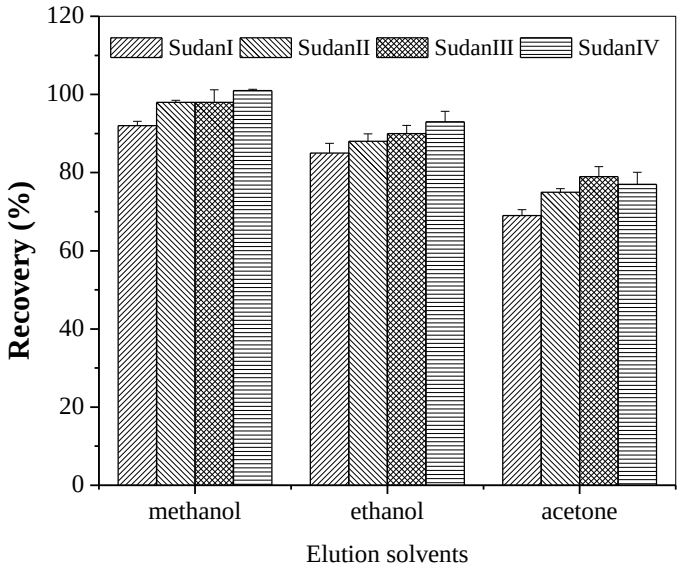

Figure S5. The effect of different solvent on the desorption of Sudan dyes from the Fe_3O_4 MNPs. Error bars represent one standard deviation for three measurements.

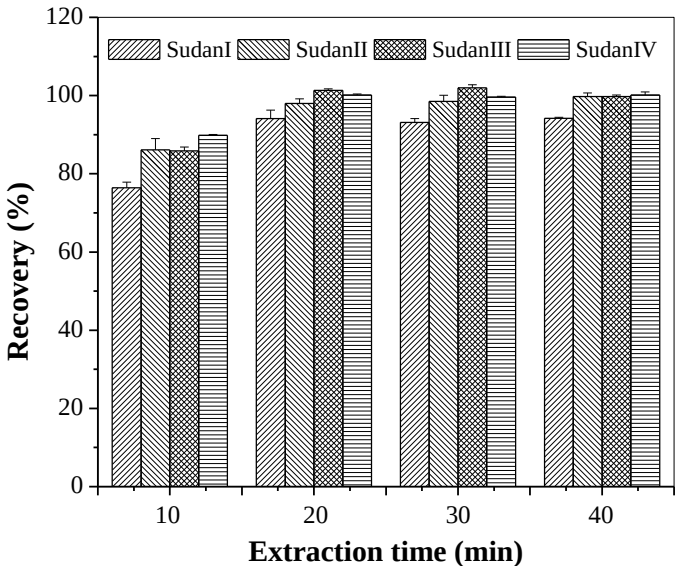

Figure S6. Effect of contact time on extraction efficiency of Sudan dyes. Sudan I-IV concentration: 5 μg L^{-1}, 5 μg L^{-1}, 20 μg L^{-1}, 40 μg L^{-1}; sample solution volume: 100 mL; Fe_3O_4 MNPs: 0.2 g; KCl concentration: 10 %; sample solution pH: 7.0; ultrasonic desorption time: 1 min. Error bars represent one standard deviation for three measurements.

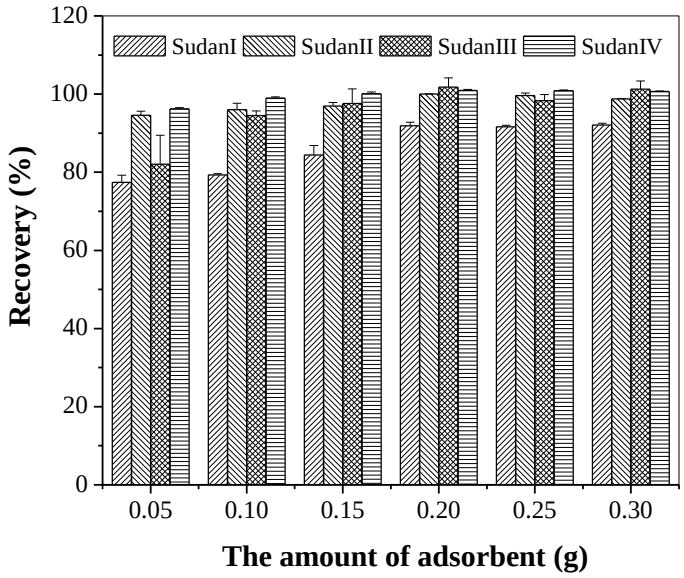

Figure S7. Effect of amounts of the adsorbents on extraction efficiency of Sudan dyes. Sudan I-IV concentration: 5 μg L^{-1}, 5 μg L^{-1}, 20 μg L^{-1}, 40 μg L^{-1}; sample solution volume: 100 mL; KCl concentration: 10 %; sample solution pH: 7.0; adsorption time: 30 min; ultrasonic desorption time: 1 min. Error bars represent one standard deviation for three measurements.