

Supplementary Information

Chitosan Based *In-Situ* and *Ex-Situ* Magnetic Iron Oxide Nanoparticles for Rapid Endotoxin Removal from Protein Solutions

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Table S1: XRD analysis data of the chitosan based iron oxide nanoparticles prepared by *in-situ* (In-3) and *ex-situ* (Ex 20:1, Ex 10:1, Ex 5:1) methods. Note: CH = Dry chitosan, CH-Gel = Glutaraldehyde cross-linked chitosan hydrogel.

Bare MNP

| Sl No. | 2 θ | d-spacing | intensity | % intensity |
|--------|------------|-----------|-----------|-------------|
| 1 | 30.176 | 2.9593 | 182 | 23 |
| 2 | 35.524 | 2.5250 | 798 | 100 |
| 3 | 43.170 | 2.0939 | 120 | 15 |
| 4 | 53.694 | 1.7057 | 70 | 9 |
| 5 | 57.324 | 1.6060 | 242 | 30 |
| 6 | 62.865 | 1.4771 | 365 | 46 |

In-3

| Sl No. | 2 θ | d-spacing | intensity | % intensity |
|--------|------------|-----------|-----------|-------------|
| 1 | 30.369 | 2.9409 | 190 | 34 |
| 2 | 35.717 | 2.5118 | 555 | 100 |
| 3 | 43.363 | 2.0850 | 99 | 18 |
| 4 | 53.694 | 1.7057 | 28 | 5 |
| 5 | 57.324 | 1.6060 | 164 | 30 |
| 6 | 62.865 | 1.4771 | 278 | 50 |

Ex 20:1

| Sl No. | 2 θ | d-spacing | intensity | % intensity |
|--------|------------|-----------|-----------|-------------|
| 1 | 30.369 | 2.9409 | 62 | 14 |
| 2 | 35.717 | 2.5118 | 454 | 100 |
| 3 | 43.170 | 2.0939 | 58 | 13 |
| 4 | 53.866 | 1.7006 | 37 | 8 |
| 5 | 57.131 | 1.6110 | 194 | 43 |
| 6 | 62.865 | 1.4771 | 266 | 58 |

Ex 10:1

| Sl No. | 2 θ | d-spacing | intensity | % |
|--------|------------|-----------|-----------|-----|
| 1 | 30.176 | 2.9593 | 202 | 30 |
| 2 | 35.524 | 2.5250 | 682 | 100 |
| 3 | 43.170 | 2.0939 | 128 | 19 |
| 4 | 53.694 | 1.7057 | 66 | 10 |
| 5 | 57.216 | 1.6088 | 236 | 35 |
| 6 | 62.672 | 1.4812 | 361 | 53 |

EX 5:1

| Sl No. | 2 θ | d-spacing | Intensity | % Intensity |
|--------|------------|-----------|-----------|-------------|
| 1 | 29.983 | 2.9779 | 46 | 13 |
| 2 | 35.331 | 2.5384 | 359 | 100 |
| 3 | 43.170 | 2.0939 | 22 | 6 |
| 4 | 53.501 | 1.7114 | 7.5 | 2 |
| 5 | 57.324 | 1.6060 | 148 | 41 |
| 6 | 63.058 | 1.4730 | 235 | 65 |

Determination of Size from Scherrer's Equation

$$L = \frac{K\lambda}{B \cos\theta}$$

L = Size of the nanocrystal

B = FWHM (Full width at half maxima)

θ = Angle

K = Scherrer's constant

λ = Wavelength

Table S2. Average particle size of the materials obtained from Scherrer's Equation

| Sample name | Size |
|--------------------|-------------|
| Bare MNP | 15.7 |
| In-3 | 13.4 |
| Ex 20:1 | 17 |
| Ex 10:1 | 17 |

Table S3. Coercivity and saturation magnetization values of different magnetic nanoparticle products.

| Sample name | Coercivity | Magnetization |
|--------------------|-------------------|----------------------|
| MNP | 24.949 G | 54.154 emu/g |
| In-3 | 19.947 G | 22.924 emu/g |
| Ex 20:1 | 24.278 G | 40.531 emu/g |
| Ex 10:1 | 20.366 G | 50.486 emu/g |