**Supplementary Data**

# Ferrofluid–based dispersive liquid–liquid microextraction using a deep eutectic solvent as a support; Application in analysis of polycyclic aromatic hydrocarbons in grilled meats

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Figure S1 shows the FT-IR spectra of $Fe_3O_4$ and $Fe_3O_4$@TEOS. The strong peak around 585 $cm^{-1}$ is attributed to Fe-O bond in $Fe_3O_4$. In comparison to Fig. S1a, Figure S1b has new peaks at 1052 (stretching vibration of Si-O bond in $SiO_2$) and 1629 and 3482 $cm^{-1}$ (related to O-H).

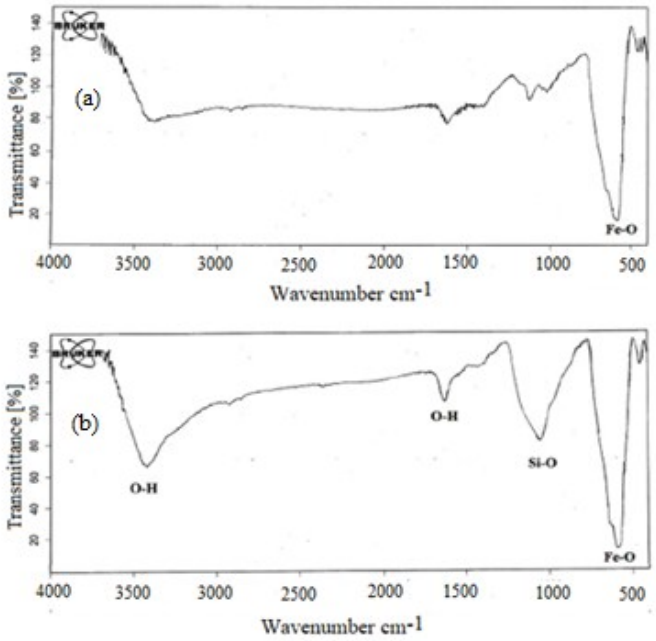


Fig. S1. FT-IR spectra of (a) $Fe_3O_4$, and (b) $Fe_3O_4$@TEOS.

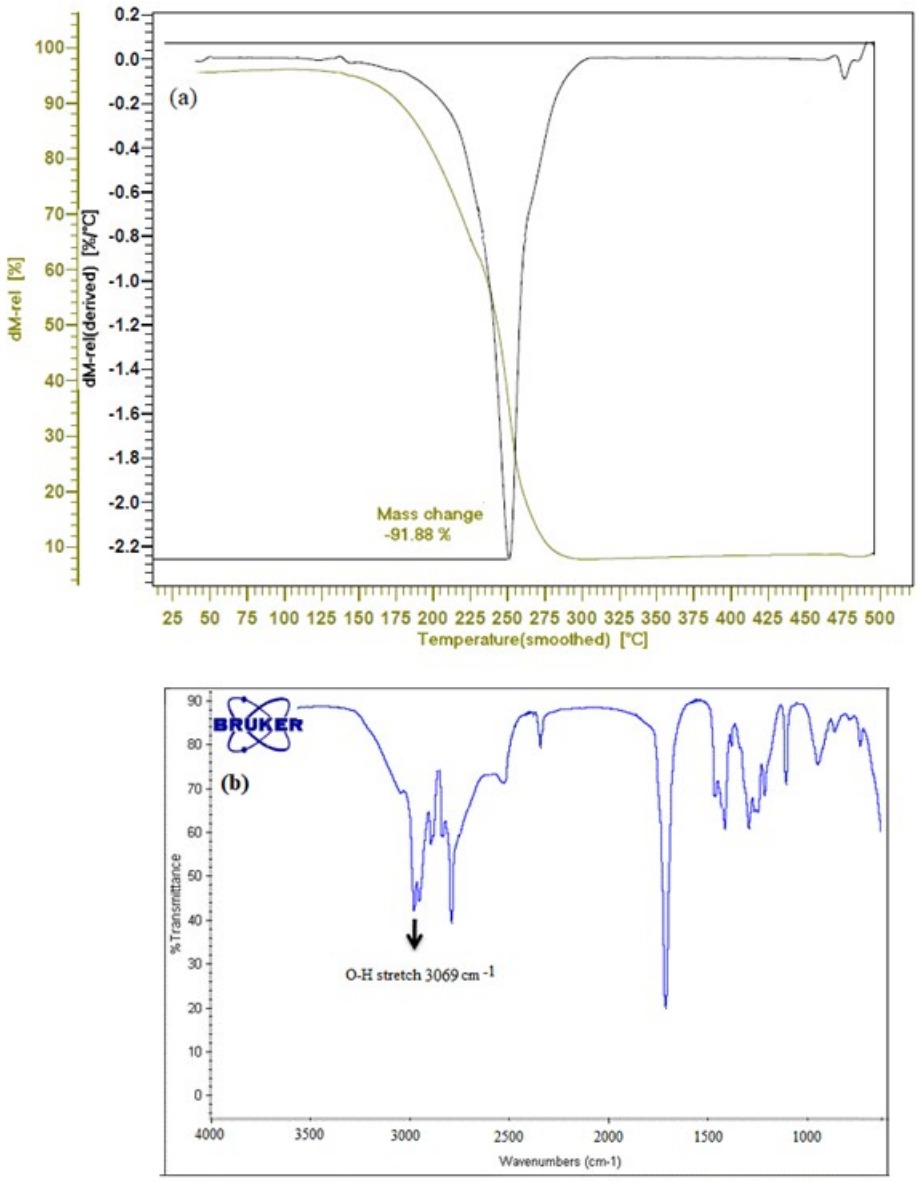


Fig. S2. TGA thermogram (a) and FT-IR spectrum (b) of the prepared DES.

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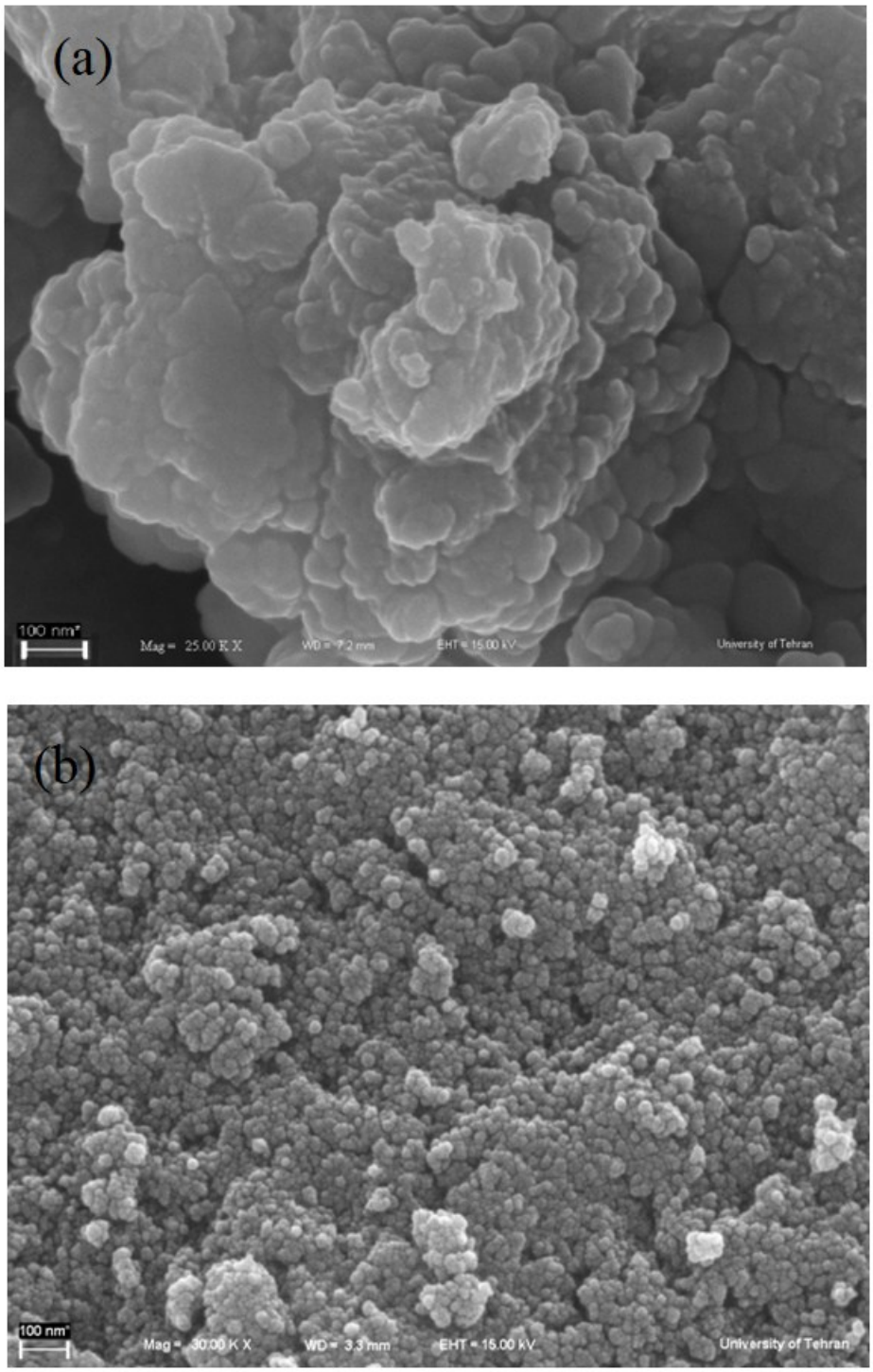


Fig. S3 SEM image of (a) the Fe3O4@TEOS magnetic nanoparticles and (b) the prepared ferrofluid.

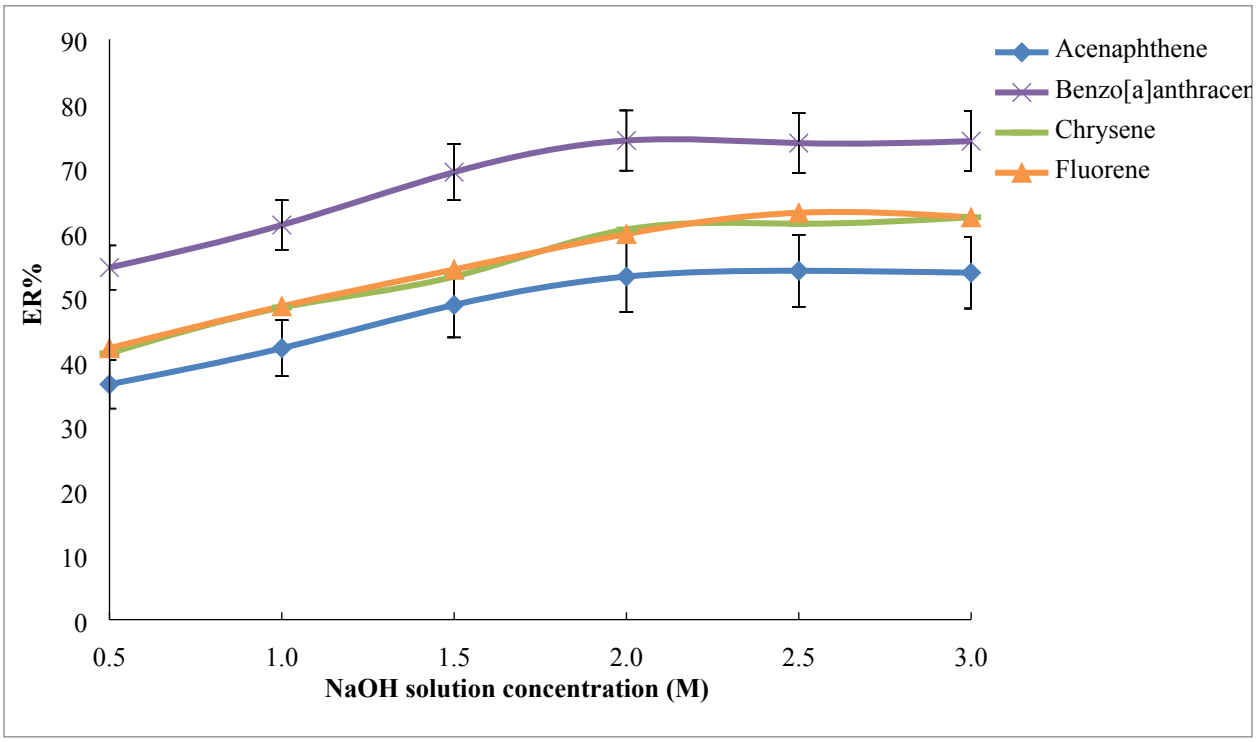


Fig. S4. Optimization of NaOH solution concentration.

Extraction conditions: sample weight, 10 g spiked with a concentration of 10 ng $g^{-1}$ of each PAH; acetonitrile volume, 2.5 mL; flow rate, 1.5 mL $min^{-1}$; solid sodium sulfate filled in extraction barrel, 2 g; extractant in DLLME (volume), $Fe_3O_4$@TEOS@PChCl:menthol:decanoic acid (100 µL); aqueous phase in DLLME, 5 mL deionized water; sonication time, 3 min and back-extraction solvent: 10 µL *n*–hexane. The error bars indicate standard deviations of three repeated determinations.

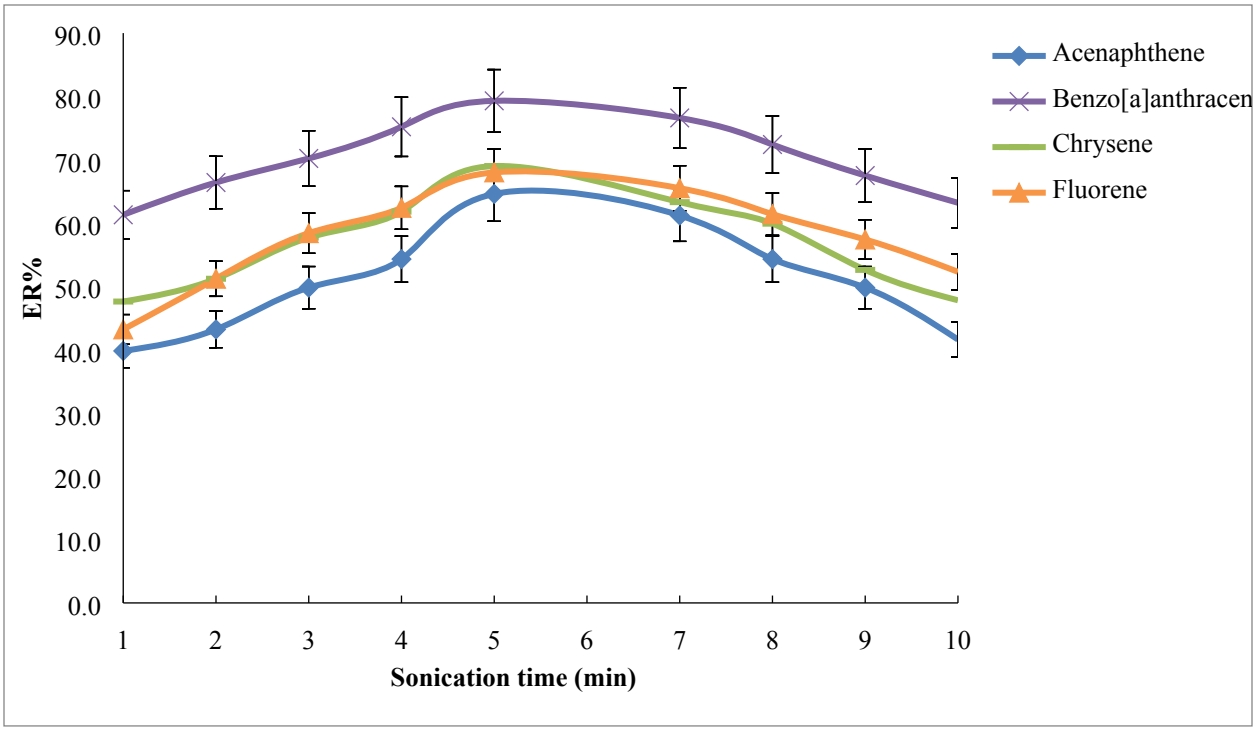


Fig. S5. Optimization of sonication time

Extraction conditions: are the same as those used in Fig. S4, except NaCl concentration which was 2M.

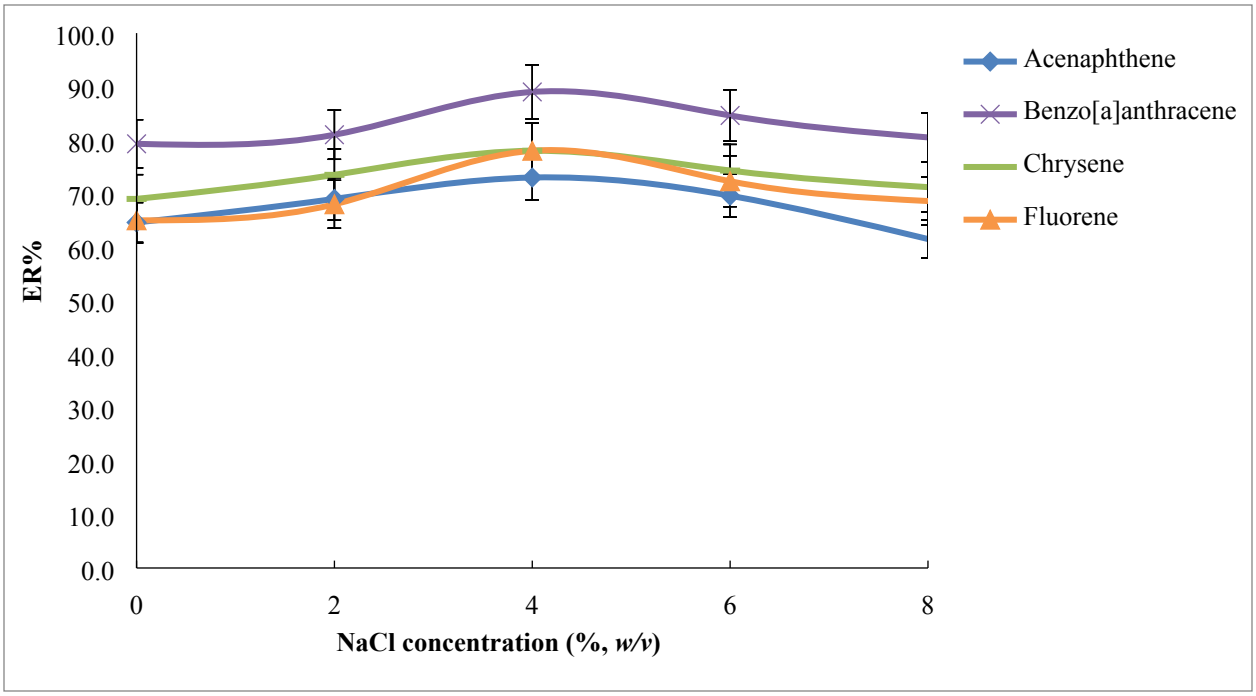


Fig. S6. Optimization of NaCl concentration

Extraction conditions: are the same as those used in Fig. 5S, except 5.0 min was selected for sonication time.

Table S1. Results of assays to check the sample matrices effect for PAHs. Analytes contents of the samples were subtracted.

| Analyte | Mean relative recovery ± standard deviation (n=3) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kebab Koobideh samples | | | | | Hamburger samples | | | | |
| | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 |
| All samples were spiked with each analyte at a concentration of 400 ng $kg^{-1}$. | | | | | | | | | | |
| Acenaphthene | 99 ± 4 | 93 ± 4 | 93 ± 6 | 92 ± 7 | 92 ± 7 | 92 ± 7 | 93 ± 5 | 92 ± 7 | 95 ± 4 | 90 ± 4 |
| Acenaphthylene | 96 ± 5 | 90 ± 4 | 91 ± 4 | 95 ± 5 | 93 ± 5 | 95 ± 5 | 90 ± 4 | 93 ± 5 | 98 ± 5 | 95 ± 7 |
| Anthracene | 92 ± 7 | 93 ± 5 | 95 ± 7 | 95 ± 5 | 90 ± 4 | 93 ± 6 | 92 ± 5 | 93 ± 6 | 90 ± 6 | 96 ± 3 |
| Benzo[a]anthracene | 95 ± 5 | 95 ± 5 | 94 ± 4 | 96 ± 3 | 93 ± 6 | 94 ± 4 | 93 ± 6 | 95 ± 5 | 93 ± 6 | 94 ± 7 |
| Benzo[b]fluoranthene | 90 ± 6 | 90 ± 4 | 92 ± 6 | 93 ± 6 | 97 ± 5 | 92 ± 3 | 92 ± 5 | 98 ± 4 | 93 ± 5 | 92 ± 5 |
| Benzo[k]fluoranthene | 94 ± 5 | 95 ± 5 | 93 ± 4 | 98 ± 4 | 93 ± 6 | 92 ± 5 | 98 ± 4 | 95 ± 7 | 93 ± 6 | 92 ± 5 |
| Benzo[ghi]perylene | 90 ± 4 | 95 ± 2 | 93 ± 6 | 91 ± 7 | 95 ± 7 | 92 ± 5 | 90 ± 7 | 92 ± 5 | 97 ± 5 | 91 ± 5 |
| Benzo[a]pyrene | 95 ± 5 | 94 ± 4 | 93 ± 6 | 97 ± 5 | 93 ± 6 | 94 ± 4 | 98 ± 4 | 92 ± 5 | 93 ± 6 | 89 ± 5 |
| Chrysene | 92 ± 7 | 93 ± 4 | 98 ± 4 | 93 ± 6 | 94 ± 5 | 94 ± 4 | 92 ± 5 | 90 ± 7 | 90 ± 6 | 92 ± 5 |
| Dibenzo[a,h]anthracene | 95 ± 7 | 91 ± 4 | 97 ± 5 | 93 ± 7 | 96 ± 6 | 93 ± 3 | 92 ± 5 | 92 ± 4 | 97 ± 5 | 93 ± 3 |
| Fluoranthene | 95 ± 7 | 94 ± 5 | 94 ± 4 | 93 ± 6 | 93 ± 6 | 95 ± 7 | 92 ± 6 | 93 ± 7 | 93 ± 6 | 94 ± 4 |
| Fluorene | 91 ± 6 | 95 ± 5 | 93 ± 6 | 92 ± 5 | 92 ± 6 | 96 ± 5 | 94 ± 5 | 94 ± 3 | 96 ± 2 | 90 ± 3 |
| Indeno[1,2,3-cd] pyrene | 92 ± 6 | 92 ± 6 | 97 ± 5 | 94 ± 5 | 95 ± 3 | 95 ± 5 | 95 ± 3 | 90 ± 5 | 96 ± 4 | 94 ± 5 |
| Naphthalene | 98 ± 6 | 93 ± 5 | 95 ± 3 | 96 ± 6 | 95 ± 3 | 94 ± 5 | 90 ± 2 | 95 ± 3 | 89 ± 5 | 95 ± 3 |
| Phenanthrene | 94 ± 4 | 90 ± 4 | 92 ± 6 | 95 ± 3 | 92 ± 5 | 90 ± 5 | 96 ± 3 | 96 ± 5 | 93 ± 4 | 96 ± 3 |
| Pyrene | 96 ± 4 | 92 ± 4 | 94 ± 5 | 94 ± 7 | 91 ± 5 | 92 ± 5 | 90 ± 5 | 94 ± 2 | 92 ± 5 | 94 ± 7 |
| All samples were spiked with each analyte at a concentration of 800 ng $kg^{-1}$. | | | | | | | | | | |
| Acenaphthene | 96 ± 2 | 92 ± 4 | 94 ± 6 | 92 ± 5 | 96 ± 5 | 90 ± 4 | 95 ± 3 | 94 ± 6 | 94 ± 2 | 98 ± 4 |
| Acenaphthylene | 90 ± 6 | 92 ± 7 | 95 ± 3 | 97 ± 5 | 99 ± 5 | 99 ± 5 | 97 ± 4 | 95 ± 5 | 92 ± 4 | 91 ± 5 |
| Anthracene | 94 ± 2 | 91 ± 5 | 92 ± 4 | 92 ± 6 | 95 ± 3 | 99 ± 5 | 92 ± 2 | 90 ± 3 | 93 ± 3 | 97 ± 5 |
| Benzo[a]anthracene | 94 ± 5 | 90 ± 8 | 97 ± 5 | 96 ± 2 | 99 ± 4 | 97 ± 3 | 94 ± 4 | 96 ± 5 | 94 ± 5 | 90 ± 7 |
| Benzo[b]fluoranthene | 94 ± 5 | 99 ± 5 | 95 ± 6 | 98 ± 2 | 97 ± 6 | 97 ± 5 | 99 ± 6 | 92 ± 5 | 96 ± 5 | 95 ± 7 |
| Benzo[k]fluoranthene | 98 ± 3 | 91 ± 2 | 93 ± 5 | 93 ± 6 | 95 ± 6 | 95 ± 5 | 92 ± 7 | 90 ± 4 | 95 ± 4 | 97 ± 4 |
| Benzo[ghi]perylene | 92 ± 5 | 98 ± 4 | 96 ± 6 | 92 ± 6 | 94 ± 5 | 91 ± 4 | 96 ± 5 | 90 ± 4 | 94 ± 5 | 90 ± 3 |
| Benzo[a]pyrene | 94 ± 5 | 99 ± 5 | 95 ± 2 | 93 ± 6 | 91 ± 3 | 92 ± 5 | 91 ± 6 | 92 ± 3 | 90 ± 6 | 90 ± 7 |
| Chrysene | 94 ± 4 | 98 ± 2 | 92 ± 6 | 96 ± 4 | 97 ± 5 | 92 ± 4 | 93 ± 5 | 89 ± 6 | 92 ± 7 | 95 ± 2 |
| Dibenzo[a,h]anthracene | 96 ± 3 | 94 ± 3 | 99 ± 7 | 95 ± 6 | 93 ± 6 | 95 ± 3 | 94 ± 7 | 95 ± 4 | 94 ± 6 | 95 ± 7 |
| Fluoranthene | 92 ± 6 | 92 ± 5 | 95 ± 4 | 92 ± 5 | 98 ± 4 | 94 ± 8 | 95 ± 5 | 90 ± 4 | 96 ± 4 | 93 ± 6 |
| Fluorene | 96 ± 7 | 92 ± 2 | 90 ± 7 | 94 ± 4 | 98 ± 5 | 95 ± 7 | 90 ± 5 | 98 ± 4 | 92 ± 4 | 93 ± 6 |
| Indeno[1,2,3-cd] pyrene | 92 ± 4 | 92 ± 3 | 92 ± 5 | 94 ± 3 | 96 ± 4 | 96 ± 2 | 98 ± 5 | 97 ± 2 | 95 ± 5 | 97 ± 5 |
| Naphthalene | 95 ± 4 | 94 ± 4 | 92 ± 5 | 94 ± 4 | 94 ± 7 | 94 ± 4 | 97 ± 4 | 92 ± 3 | 94 ± 6 | 92 ± 4 |
| Phenanthrene | 95 ± 6 | 94 ± 5 | 92 ± 6 | 92 ± 6 | 90 ± 5 | 95 ± 4 | 95 ± 7 | 92 ± 4 | 98 ± 2 | 94 ± 6 |
| Pyrene | 92 ± 6 | 95 ± 3 | 94 ± 5 | 95 ± 6 | 93 ± 5 | 92 ± 5 | 94 ± 7 | 90 ± 4 | 92 ± 5 | 90 ± 7 |