

Development of a Modified QuEChERS method based on Magnetic Multiwalled Carbon Nanotubes as a Clean-up Adsorbent for the Analysis of Heterocyclic Aromatic Amines in Braised Sauce Beef

Min Li ¹, Pengxiang Wang ¹, Xu Zhang ¹, Hongyu Wang ¹, Ke Li ¹, Yanhong Bai ^{1,2,*}

¹ College of Food and Bioengineering, Zhengzhou University of Light Industry, Zhengzhou 450001, China

² Henan Key Laboratory of Cold Chain Food Quality and Safety Control, Zhengzhou 450001, China

* Correspondence: baiyanhong212@163.com

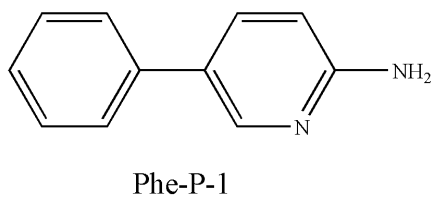
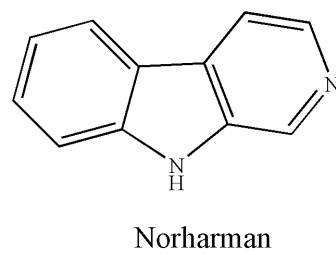
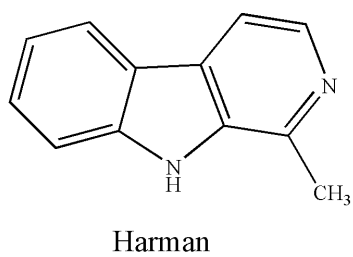
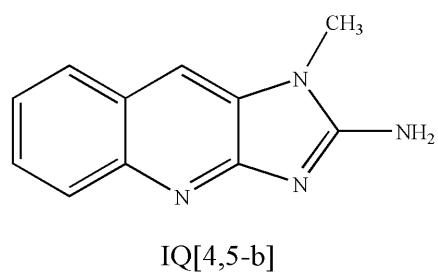
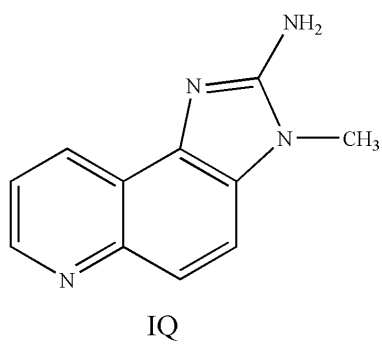


Figure S1. Chemical structures of the studied HAAs.

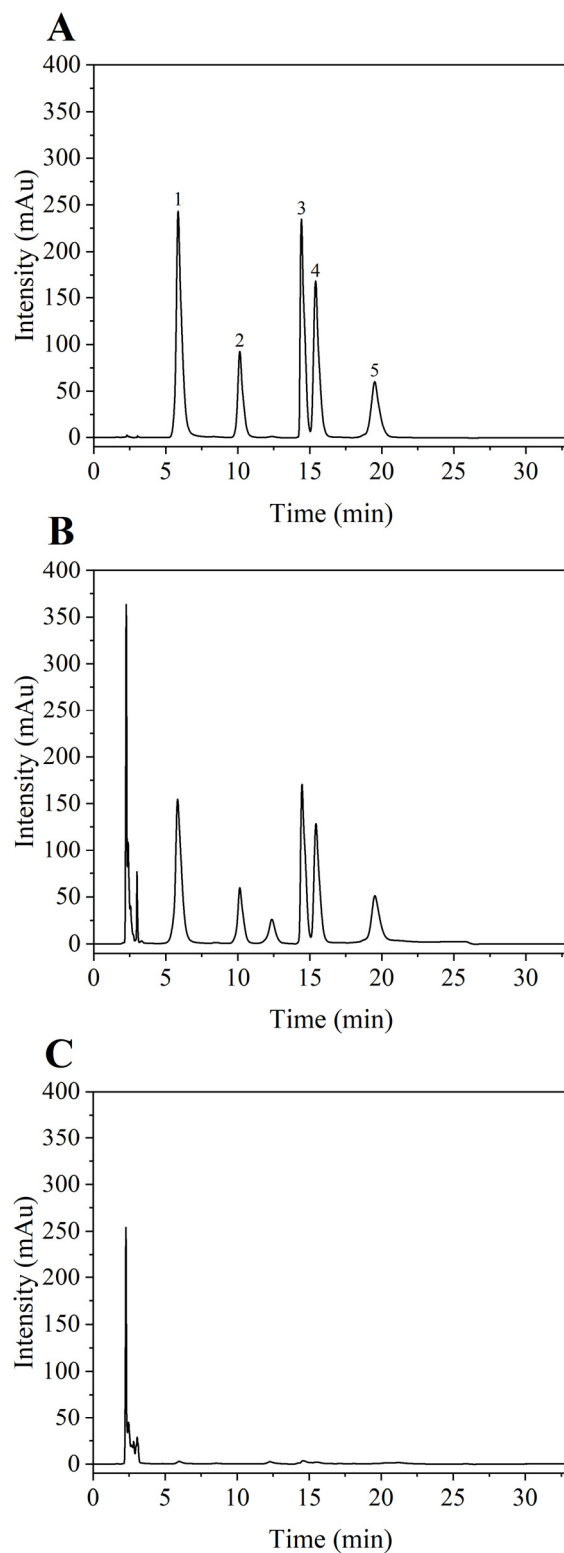


Figure S2. Chromatograms of the mixed standard solution (**A**), the spiked braised sauce beef extract (**B**) and the blank braised sauce beef extract (**C**) prepared with the proposed QuEChERS method. Peak assignments: (1) IQ, (2) IQ[4,5-b], (3) Harman, (4) Norharman, (5) Phe-P-1. Spiked concentrations, 1.0 $\mu\text{g/g}$ for IQ, Harman and Norharman, 0.5 $\mu\text{g/g}$ for IQ[4,5-b] and Phe-P-1.

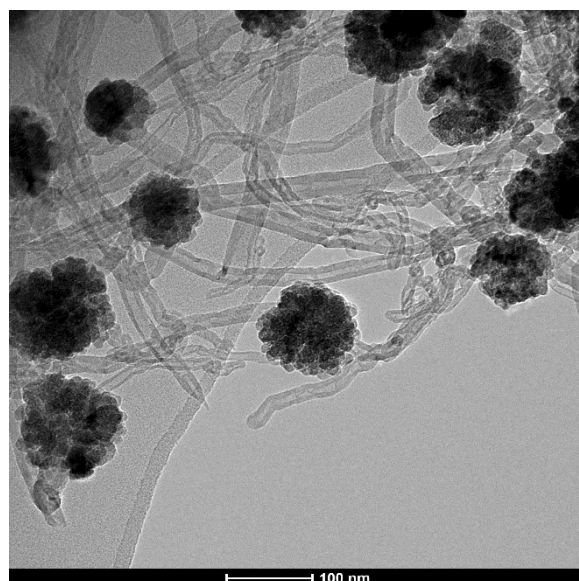


Figure S3. TEM image of Fe₃O₄-MWCNTs.

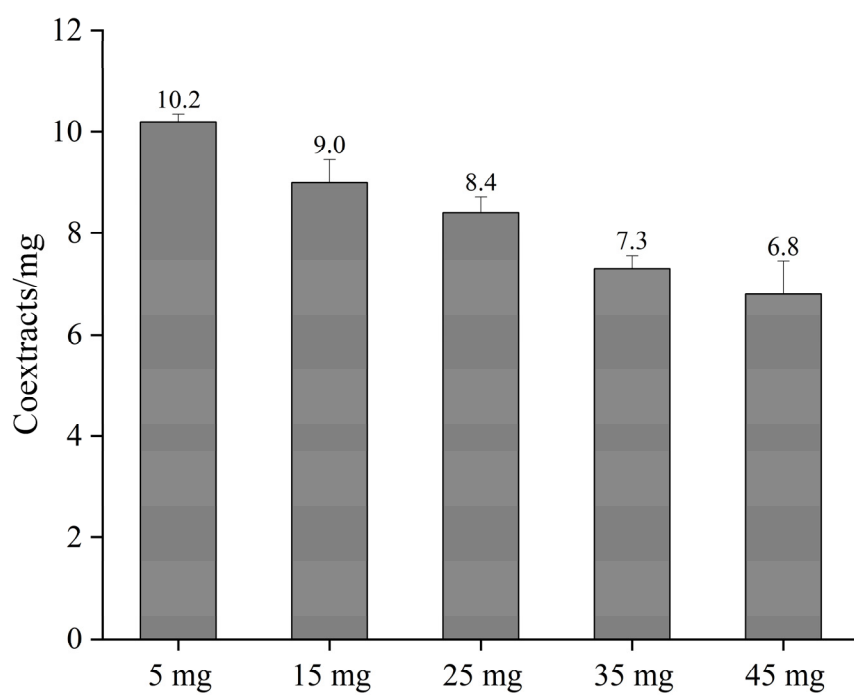


Figure S4. Amount of co-extracted matrix obtained through gravimetric analysis after purification with different amounts of Fe₃O₄-MWCNTs in the QuEChERS method (n = 3).

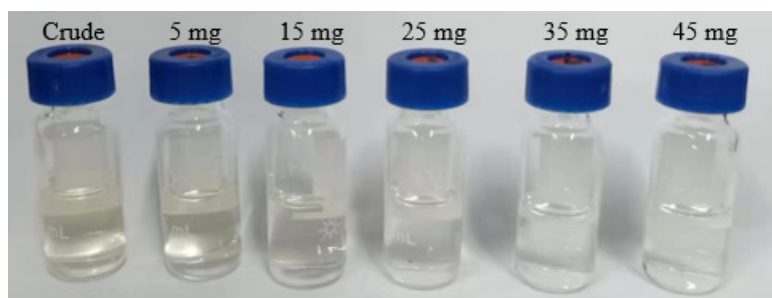


Figure S5. Photographs of braised sauce beef extract after purification with different amounts of Fe₃O₄-MWCNTs.

Table S1. HAAs measured in analyzed braised sauce beef samples.

Samples	IQ	IQ[4,5-b]	Harman	Norharman	Phe-P-1
Beef 1	n.q. ¹	-	n.q.	n.q.	-
Beef 5	n.q.	-	-	-	-
Beef 8	n.q.	-	n.q.	n.q.	-
Beef 13	n.q.	-	n.q.	n.q.	-
Beef 14	n.q.	-	n.q.	n.q.	-

¹ n.q.-not quantified (<LOQ), HAAs could be detected but not quantified.