Supporting information

Rational design of L-histidine-stabilized fluorescent copper nanoclusters for highly selective and sensitive detection of sunset yellow

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1. Experimental section

1.1 Chemicals

The reagents listed are L-Histidine (His), produced by Guoyao; Copper(II) chloride dihydrate ($CuCl_2 \cdot 2H_2O$), also from Guoyao; Ascorbic acid (AA) from Guoyao; Sunset Yellow (SY) sourced from Aladdin; Sodium nitrite ($NaNO_2$) from Guoyao; Zinc sulfate heptahydrate ($ZnSO_4 \cdot 7H_2O$) from Shengong; Barium chloride dihydrate ($BaCl_2 \cdot 2H_2O$) from Guoyao; Potassium chloride (KCl) from Guoyao; Sodium carbonate (Na_2CO_3) from Shengong; Silver nitrate ($AgNO_3$) from Guoyao; Arginine (Arg) from Guoyao; D-Penicillamine (DPA) from Aladdin; and Methionine (Met) from Guoyao. This comprehensive list highlights the sources of important chemical substances for analytical purposes.

1.2 Visual Sensing of SY

To better apply the detection of SY using His-CuNCs in practical scenarios, a smartphone and color recognition software were used for sample analysis. After incubating His-CuNCs with different concentrations of SY solution (15, 30, 45, 60, 75, 90 μM) for 30 minutes, the mixture was observed and photographed under a 365 nm UV lamp. The RGB values of fluorescent images were extracted and analyzed using the "Color Coll" software. To explore the feasibility of His-CuNCs in practical applications, the content of SY in actual samples was detected. Sunset Yellow (a composite coloring agent) was purchased for use in juices, candies, and pastries to enhance the color of food and improve appetite. Approximately 10 mg of the additive powder was weighed and dissolved in an appropriate amount of ultrapure water to prepare the actual sample solution. Subsequently, different concentrations of SY were injected into the sample solution to prepare spiked samples. The spiked sample solution was incubated with 200 μL of His-CuNCs solution and diluted with ultrapure water to 2.00 mL. After sufficient reaction, the fluorescence intensity was measured using a fluorescence spectrophotometer.

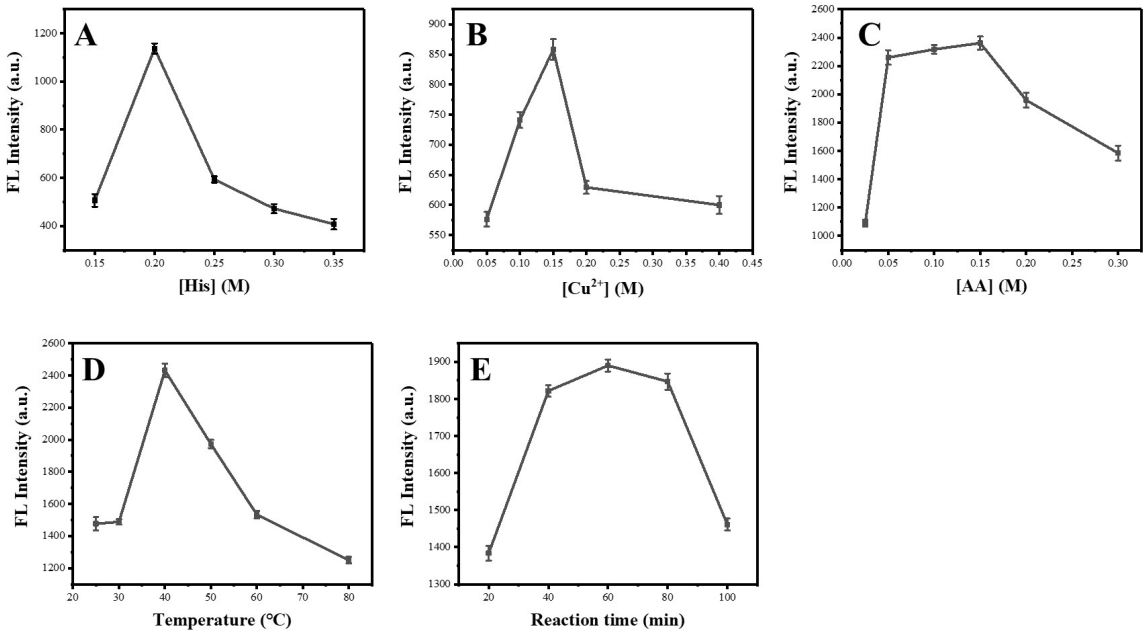

Figure S1. Optimization of His and $CuCl_2 \cdot 2H_2O$ concentrations in the preparation of His-CuNCs (A-B); (C) Optimization of ascorbic acid concentration in the synthesis of CuNCs; Optimization of reaction temperature (D) and time (E) during His-CuNCs synthesis.

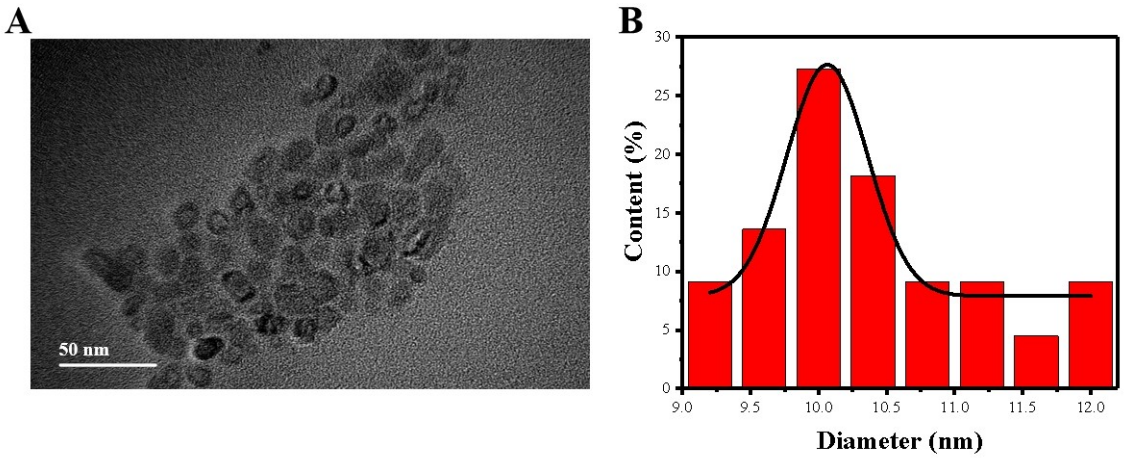

Figure S2. (A) TEM images of His-CuNCs/SY; (B) The size distribution histogram of His-CuNCs/SY.

Table S1. Comparison of other fluorescence methods for SY detection.

Probes	Liner range (μM)	LOD (nM)	Ref.
CMCS@N, S-CDs/Rh6G[a]	0.26–100.0	78.0	[1]
F-AC[b]	0-30.0	195.0	[2]
CDs-PTD[c]	0-180.0	106.8	[3]
rGO[d]-CdS	0-90.9	7890.0	[4]
CB7[e]·luteolin	0.5-50.0	120.0	[5]
CDs	0.25-60.0	200.0	[6]
His-CuNCs	0.3-90.0	15.34	This work

Note: CMCS-CDs/Rh6G[a]: carboxymethyl chitosan-carbon dots/rhodamine 6G; F-AC[b]:Fluorescent aminoclay; PTD[c]: 3,4,9,10-pertetracarboxylic dianhydride; rGO[d]: reduced graphene oxide; CB7[e]:cucurbit.

Table S2. Parameters of fluorescence lifetime decay curve.

Sample	τ_1 (ns)	Percentage (%)	τ_2 (ns)	Percentage (%)	τ_{ave} (ns)
His-CuNCs	1.8258	34.68	6.5079	65.32	4.8841
His-CuNCs/SY	1.7014	32.32	6.3812	67.68	4.8688

References

[1] J. Zhang, H. Qi, T. Yi, T. Jing, M. Zhao, J. Li, M. Ran, X. Zhu, C. Luo, Development of a highly sensitive ultra-small ratiometric fluorescence nanosphere probe for sunset yellow detection, Talanta 277 (2024) 126341.

[2] Y. Guo, J. Shi, C. Wei, T. Fang, T. Tao, One-pot synthesis of fluorescent aminoclay and the ratiometric fluorescence detection of sunset yellow, Dyes and Pigments 212 (2023) 111102.

[3] J. Xu, J. Sun, F. Yan, H. Zhang, R. Ma, Y. Zang, S. Guan, X.J.P. Wang, P.S. Characterization, Fluorescence sensing performance of carbon dots of functionalization toward sunset yellow, Particle & Particle Systems Characterization 39 (2022) 2100207.

[4] M. Kaur, A. Umar, S.K. Mehta, S.K. Kansal, Reduced graphene oxide-CdS heterostructure: an efficient fluorescent probe for the sensing of Ag(I) and sunset yellow and a visible-light responsive photocatalyst for the degradation of levofloxacin drug in aqueous phase, Applied Catalysis B: Environmental 245 (2019) 143-158.

[5] S. Wu, Y. Zhang, L. Yang, C.-P.J.J.o.F.Q. Li, Label-free fluorescent determination of sunset yellow in soft drinks based on an indicator-displacement assay, Journal of Food Quality 1 (2018) 6302345.

[6] A. Kaur, U. Gupta, I. Hasan, R. Muhammad, R.A. Khan, Synthesis of highly fluorescent carbon dots from spices for determination of sunset yellow in beverages, Microchemical Journal 170 (2021) 106720.