Automated Sample Pretreatment Device Based on Microfluidic Chip Online Coupled with ICP-MS for Bacteremia Diagnosis

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Materials and instruments

Monoclonal antibodies for Salmonella (anti-5H12 and anti-8G3) and E. Coli O157:H7 (anti-7C2 and anti-8B1) were acquired from HASEKI (Shanghai, China). From Thermo Fisher Scientific, 1 μm carboxylated magnetic beads (MBs-COOH) were acquired. The supplier of chloroauric acid was Shanghai Chemical Reagent Company. Aladdin Reagent Company provided the sodium citrate, morpholineethanesulfonic acid (MES), and bovine serum albumin (BSA). From Sigma-Aldrich, N-(3-dimethylaminopropyl)-N-ethylcarbodiimide hydrochloride (EDC) was acquired. 10 mmol L^{-3} PBS contains 2.7 mmol L^{-1} KCl, 1.5 mmol L^{-1} KH_2PO_4, 137 mmol L^{-1} NaCl, and 8 mmol L^{-1} K_2HPO_4. The contents of 10 mmol L^{-1} PBST are 0.05% Tween 20 and 10 mmol L^{-1} PBS, as well as 100 mmol L^{-1} MEST. The composition of TSB tryptic soy broth medium (for the culture of E. Coli O157:H7 and Salmonella) includes NaCl 5.0 g L^{-1}, tryptone 17.0 g L^{-1}, soybean peptone 3.0 g L^{-1}, glucose 2.5 g L^{-1}, and K_2HPO_4 2.5 g L^{-1}. TSA tryptic soy agar, compositionally similar to TSB, includes solid agar as a solid medium. Polydimethylsiloxane (PDMS) chips were made of PDMS and a glass substrate, using AZ-50XT photoresist for soft lithography. PDMS (GE RTV 615, Momentive performance materials, USA) was prepared by mixing oligomers and crosslinkers in different ratios and then heating. Sample introduction and reception in the microfluidic chip used polytetrafluoroethylene (PTFE) tubes. High-intensity neodymium-iron-boron magnets were used, and reagents were at least of analytical grade. The experiment was conducted using ultrapure water (18.25 MΩ·cm).

NexION 1000G PerkinElmer was used to detect ^{197}Au and ^{107}Ag with operating parameters of ICP-MS in Table S1 and pH was measured using a Mettler Toledo 320-S pH meter.

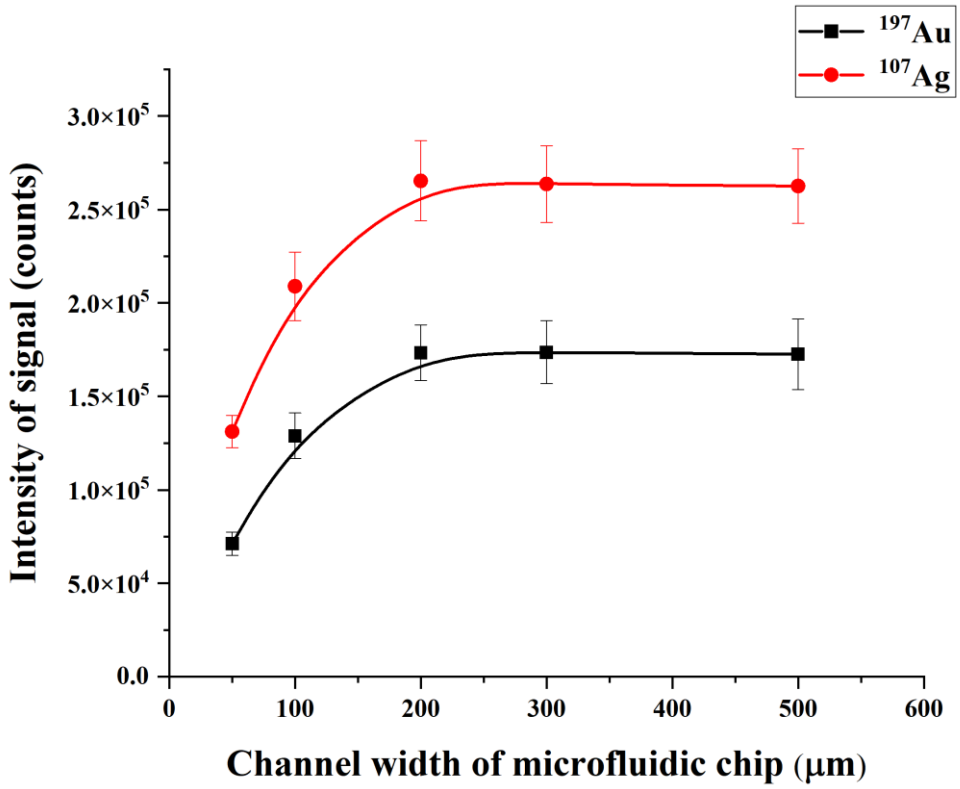

Fig. S1 Effect of the channel width of microfluidic chip on the signal intensity of ^{197}Au and ^{107}Ag.

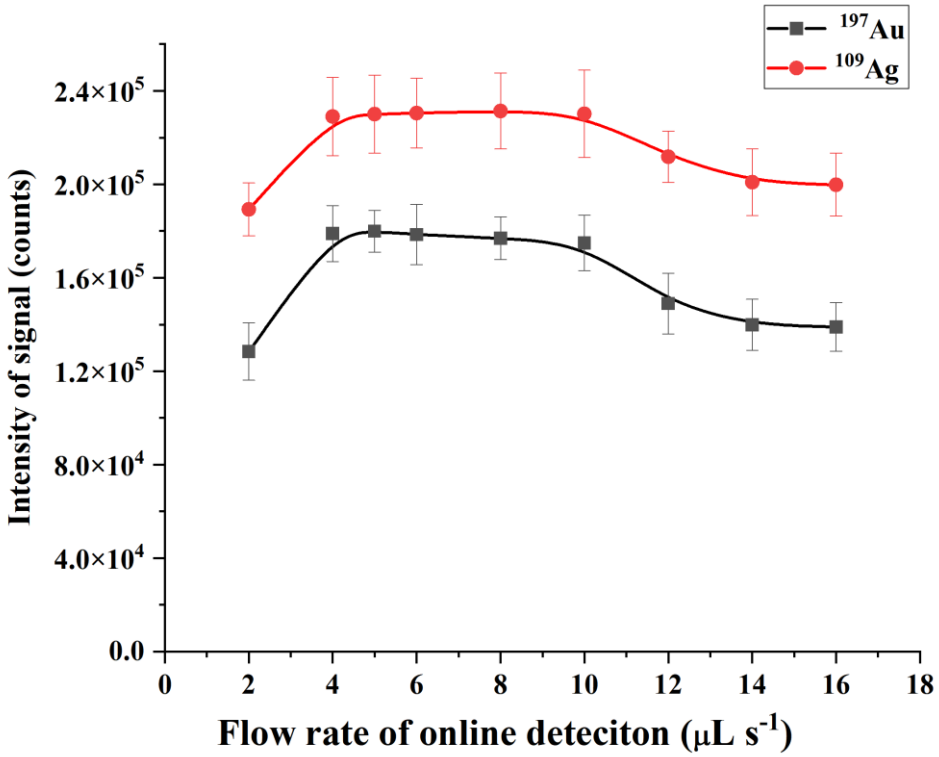

Fig. S2 Flow rate effect of online detection on the signal intensity of the ^{197}Au and ^{107}Ag.

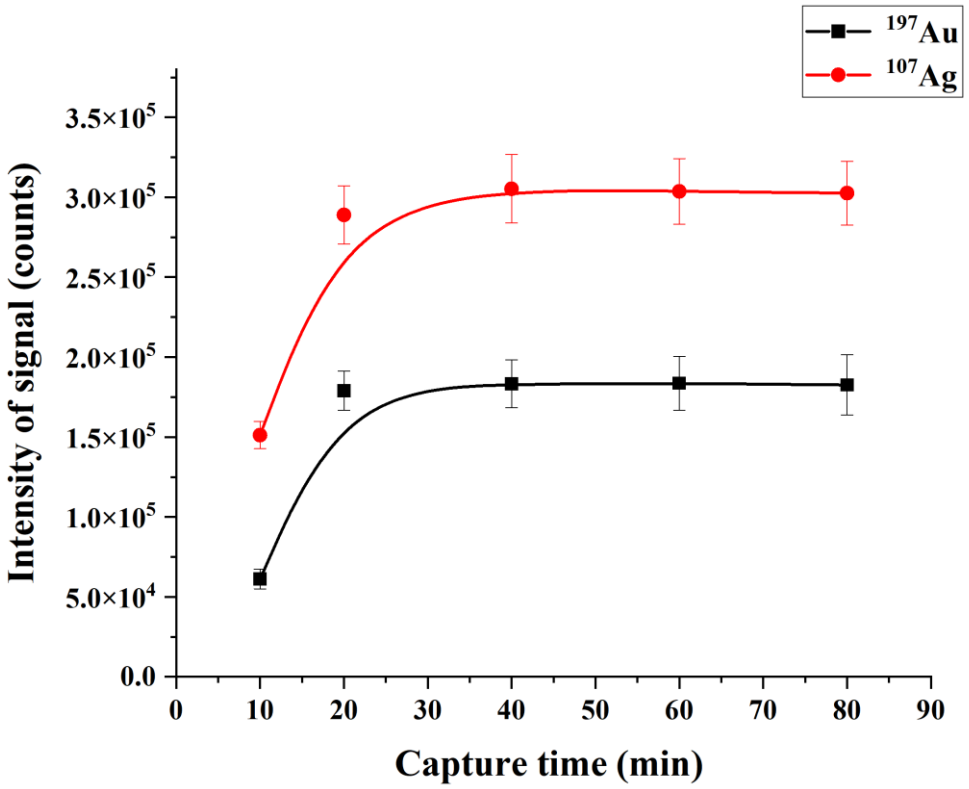

Fig. S3 Effect of capture time for E. Coli O157:H7 and Salmonella.

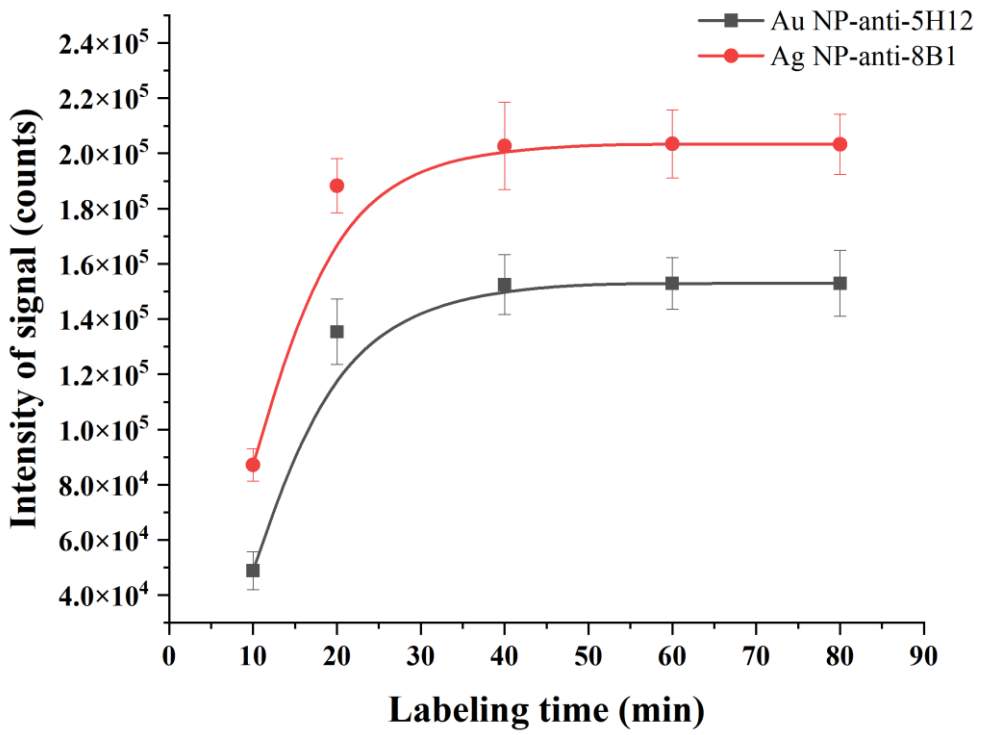

Fig. S4 Influence of labeling time on Salmonella and E. Coli O157: H7.

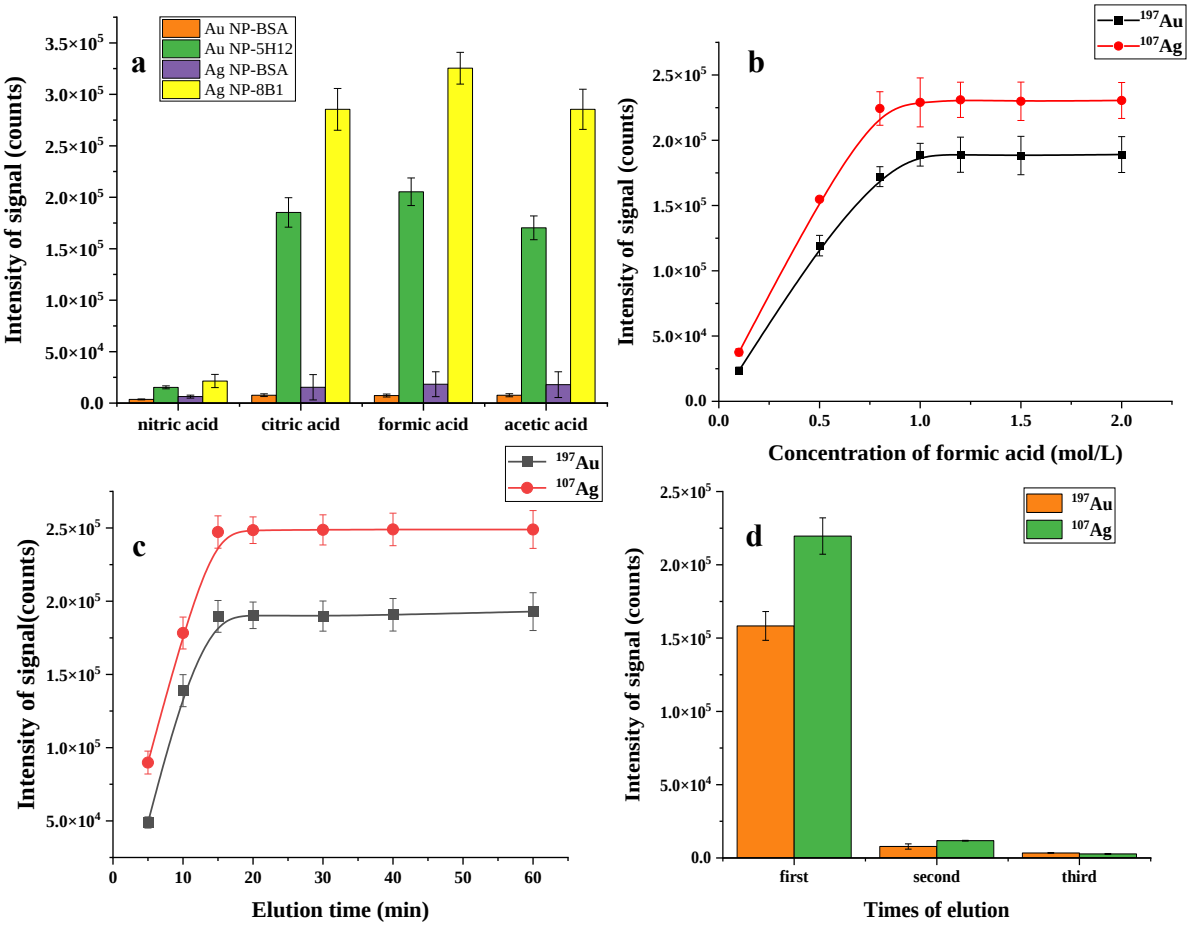

Fig. S5 Influence of the elution conditions on the signal intensity of ^{107}Ag and ^{197}Au.

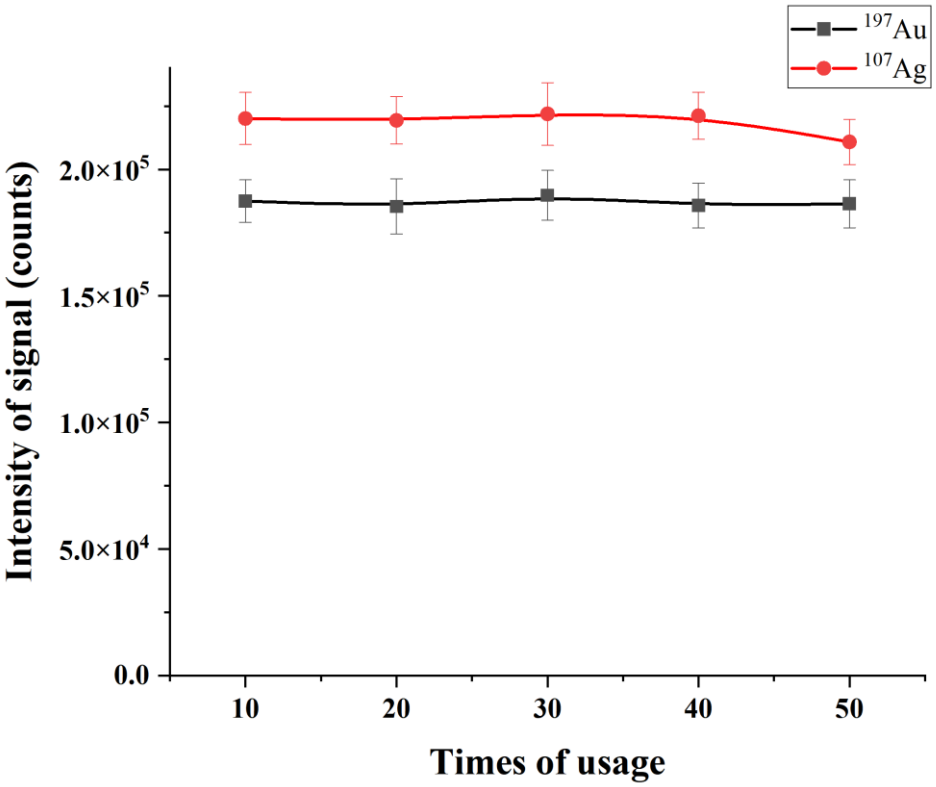

Fig.S6 Investigation on the chip usage life

Table S1 Operating parameters of ICP-MS

ICP-MS plasma	Parameters
Rf power	1600 W
Plasma gas flow (Ar)	15 L min^{-1}
Auxiliary gas flow (Ar)	1.2 L min^{-1}
Nebulizer gas flow (Ar)	1.04 L min^{-1}
Scanning mode	Peak-jumping
Dwell time	50 ms
Monitored isotope	^{197}Au, ^{107}Ag

Table S2 The specific settings of the PLC

Steps	inlet	outlet	flow rate	reaction
capturing	A1	A5	5 μL s^{-1}	Stand for 20 min
washing	A2	A5	5 μL s^{-1}	3 min
labeling	A3	A5	5 μL s^{-1}	Stand for 20 min
washing	A2	A5	5 μL s^{-1}	3 min
eluting	A4	A6	5 μL s^{-1}	Stand for 15 min

Table S3 The comparison of several bacteria detection techniques

Analytic methods	Target analytes	Limits of detection	Real samples	References
SERS immunosensors	S. typhimurium	100	Cottage, cheese	29
Electrical voltage detection	Salmonella	33	-	30
Impedimetric detection	E. coli O157: H7	500	Egg shell wash samples and tap water	31
Colorimetric detection	Salmonella	60	vegetables	32
Fluorescent detection	E. coli O157: H7	240	-	33
ICP-MS Detection	E. coli O157: H7	100	-	19
SP-ICP-MS Detection	Escherichia coli, Staphylococcus aureus, Listeria monocytogenes Shigella dysenteriae Vibrio parahemolyticus	1	-	34
ICP-MS Detection	E. coli O157: H7 and Salmonella	152 200	Human blood	This work