Expert Insights

Improving Foodborne Disease Prevention and Control

GP

Working with Bruker

The Jiangxi Provincial Center for Disease Control and Prevention has worked in collaboration with Bruker using the IR Biotyper® instrument to improve screening and accelerate decision-making in disease outbreak control.

Jiangxi Provincial Center for Disease Control and Prevention
Institute of Nutrition and Food Safety
National Reference Laboratory for Salmonella in Food Safety Risk Monitoring
Jiangxi Key Laboratory for Major Epidemic Prevention and Control

Food safety remains a critical global concern, with unsafe food responsible for an estimated 600 million cases of foodborne illness and 420,000 deaths annually, affecting nearly one-tenth of the world's population each year.[1] In China, foodborne disease outbreaks continue to pose a significant public health threat, due to the widespread prevalence of foodborne pathogens.

The Institute of Nutrition and Food Safety at the Jiangxi Provincial Center for Disease Control and Prevention (Jiangxi CDC) in China is at the forefront of addressing these concerns. With extensive expertise and practical experience in the field, the Jiangxi CDC serves as the region's Key Laboratory for Major Epidemic Prevention and Control and the National Reference Laboratory for *Salmonella* in Food Safety Risk Monitoring.

In collaboration with Bruker Microbiology & Infection Diagnostics, the Jiangxi CDC is developing new rapid screening solutions based on microorganism strain typing, to address the growing problem of foodborne illness, specifically *Salmonella*. This work supports broader food safety strategies across China, improving tracing accuracy and response times to outbreaks, to ultimately protect public health at both local and national levels.

The challenge of *Salmonella*

Salmonella is a common foodborne pathogen that can cause illnesses, including food poisoning, enteritis, typhoid, and paratyphoid fever. Infection occurs primarily through contaminated food, and, without timely diagnosis and treatment, complications can become life-threatening. According to the World Health Organization, invasive non-typhoidal serotypes of *Salmonella enterica* were estimated to cause over 500,000 invasive disease illnesses associated with more than 79,000 deaths in 2019, with a high case fatality ratio of 14.5%.[2]

Accurate serogrouping (identifying *Salmonella* strains sharing the same somatic O antigen) and serotyping (differentiating *Salmonella* strains within a serogroup based on their specific combinations of surface antigens) are crucial for epidemiological investigations, foodborne outbreak control, and clinical management. Globally, the recognized standard for *Salmonella* typing relies on serotyping based on the agglutination reaction of O and H antigens with specific antisera.[3] However, the complex antigenic structure of *Salmonella* means isolates from different regions or time periods may vary. Furthermore, strains of the same serotype may present different characteristics. Distinguishing these differences, which is not possible using conventional serotyping, is highly complex, costly, and time-consuming, and therefore limited to only a few specialized reference laboratories.

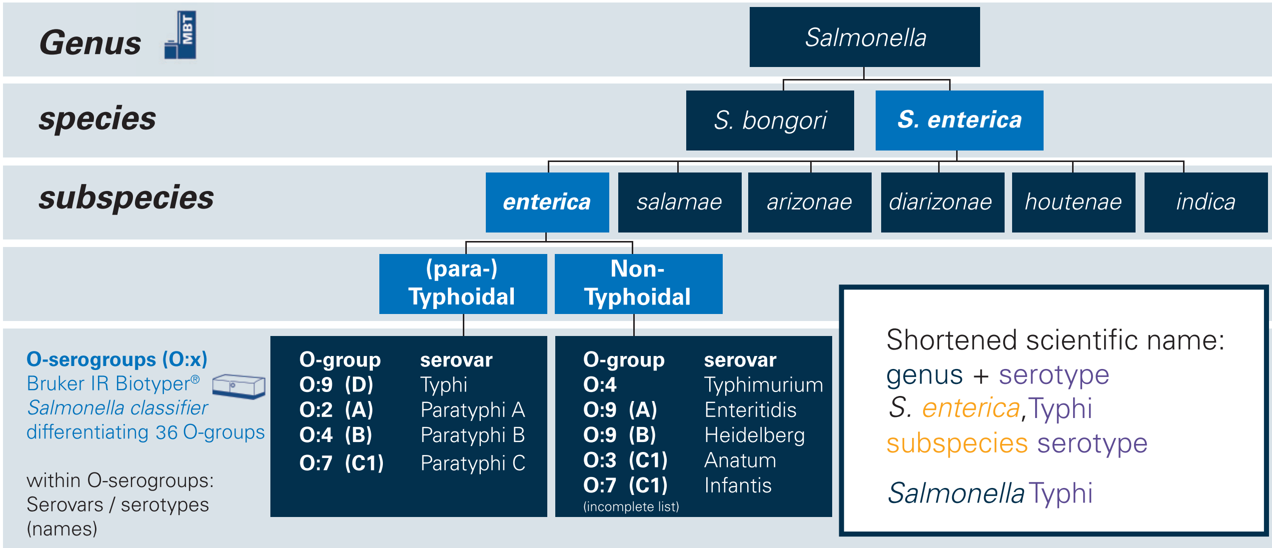


Figure 1
Salmonella taxonomy

Collaborating with Bruker on a rapid screening solution

Scientists at the Jiangxi CDC use the MicroVal-certified Bruker MALDI Biotyper® system to reliably detect and confirm *Salmonella* at the genus level.

However, since more than 99% of clinically relevant isolates belong to *Salmonella enterica*, routine MALDI-TOF MS analysis does not typically discriminate between the two known species (*S. enterica* and *S. bongori*). Within *S. enterica*, six subspecies are recognized, of which subspecies *enterica* (subsp. I) is most frequently associated with human disease.

Further classification is achieved by serogrouping and serotyping: serogroups are defined by the O antigens of the outer membrane (e.g., O:4, O:9), whereas serotypes represent more precise antigenic formulas that combine O and H (flagellar) antigens. Clinically, serotypes are grouped into typhoidal (e.g. *S.* Typhi, *S.* Paratyphi A/B/C), which can cause systemic typhoid-like fever, and nontyphoidal (e.g. *S.* Enteritidis, *S.* Typhimurium), which are typically associated with self-limiting gastroenteritis, but can also cause invasive disease in vulnerable populations.

Traditional *Salmonella* typing methods face several challenges. For example, genotype-based technologies, while offering high resolution, involve cumbersome procedures that hinder widespread practical application. Phenotype-based technologies, such as agglutination tests, have low sample throughput, and results rely on subjective interpretation since no reporting is available. This compromises accuracy and, if results are lost, the whole procedure needs to be repeated. Molecular serotyping technologies are also expensive, restricting their large-scale use.

A practical strain typing solution

The Bruker IR Biotyper® microbial infrared (IR) spectroscopy typing system was introduced at the Jiangxi CDC in November 2023. It uses Fourier-transform infrared (FT-IR) spectroscopy technology to rapidly discriminate microbial strains, and its software solution enables microbial strains commonly found in food and beverage products to be classified using standard or user-defined classifiers.

The IR Biotyper can be used with machine learning as a rapid screening solution for typing 36 *Salmonella* O-serogroups from a single test, with discriminatory power comparable to molecular methods. Since strains of different serotypes exhibit variations in surface antigens, their IR spectral profiles also differ. The team at the Jiangxi CDC collected more than 500 suspected foodborne disease-related strains from hospitals, food markets, restaurants, and outbreak areas using this method. These strains underwent dual validation via serological agglutination tests and whole-genome sequencing (WGS), ultimately confirming more than 200 as target strains.

Using these 200 target strains, samples were prepared following the IR Biotyper standard protocol. All spectra were obtained and analyzed using the IR Biotyper software and carefully compared with serological agglutination serotyping and WGS results. By collecting extensive amounts of spectral data and training the model with machine learning algorithms, the team at the Jiangxi CDC achieved rapid serotype classification of common highly pathogenic serotypes within the *Salmonella* O:4 serogroup.

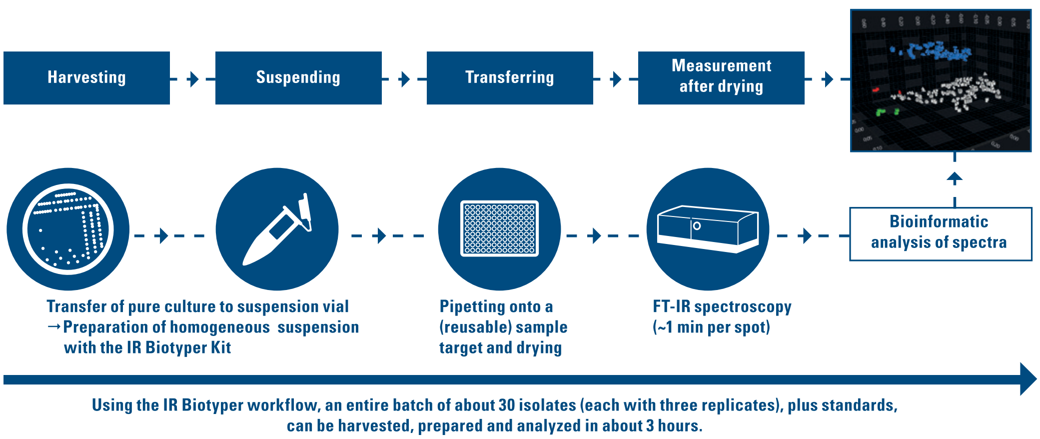


Figure 2
IR Biotyper® Workflow

Rapid tracing of *Campylobacter jejuni*

IR Biotyper technology has also helped the Jiangxi CDC achieve remarkable results in tracing other foodborne pathogens.

In a case of neonatal *Campylobacter jejuni* infection, the team used the IR Biotyper technology for strain tracing and typing isolates from an infant patient, family members, and their home. Cluster analysis with exploratory data analysis such as dendrograms, 2D and 3D scatter plots, clearly illustrated the homology between the isolates. The tracing results were highly consistent with WGS-based findings, accurately identifying the transmission chain. The source of contamination was found to be a live chicken. After the infant's grandmother had prepared the infected poultry, she failed to wash and disinfect her hands and kitchen tools before preparing the baby's milk formula, creating a transmission chain involving the grandmother, the feeding bottle, the formula, and the infant.

This not only validates the reliability of the IR Biotyper technology in foodborne disease tracing but also provides critical evidence for subsequent prevention efforts. The case demonstrates the dual value of the IR Biotyper in enabling rapid and precise typing in foodborne disease tracing and in informing preventative measures to halt transmission chains.

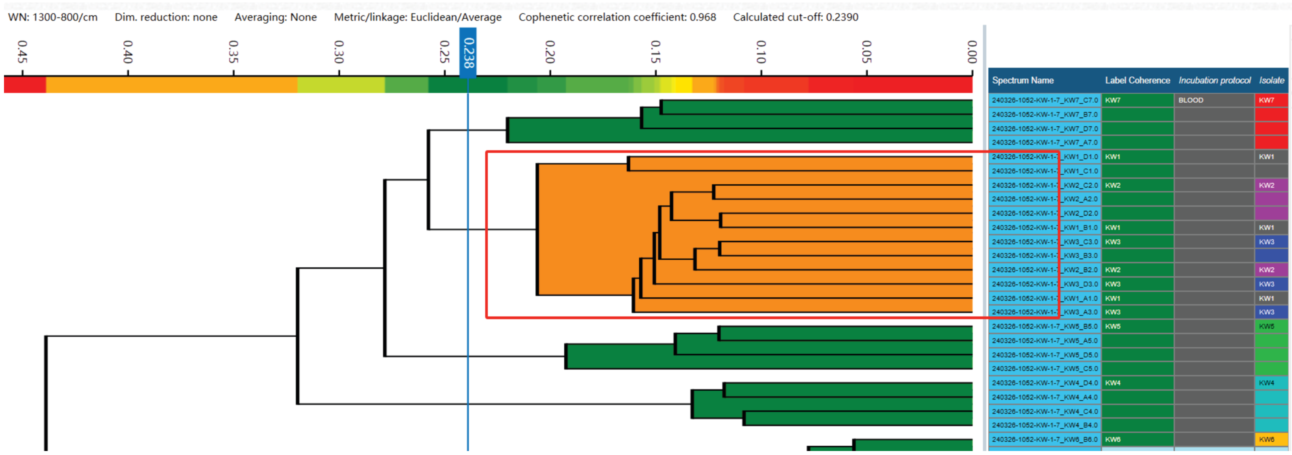
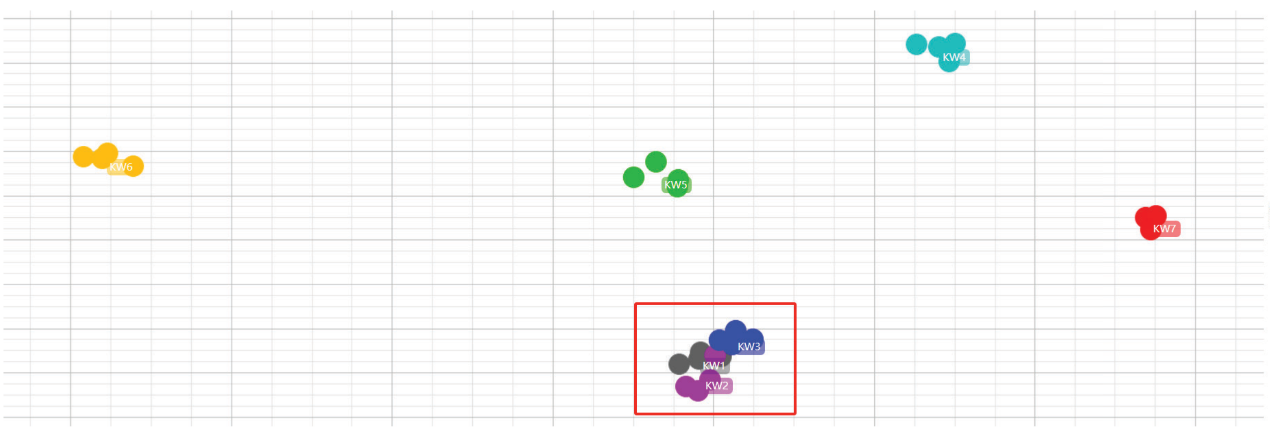
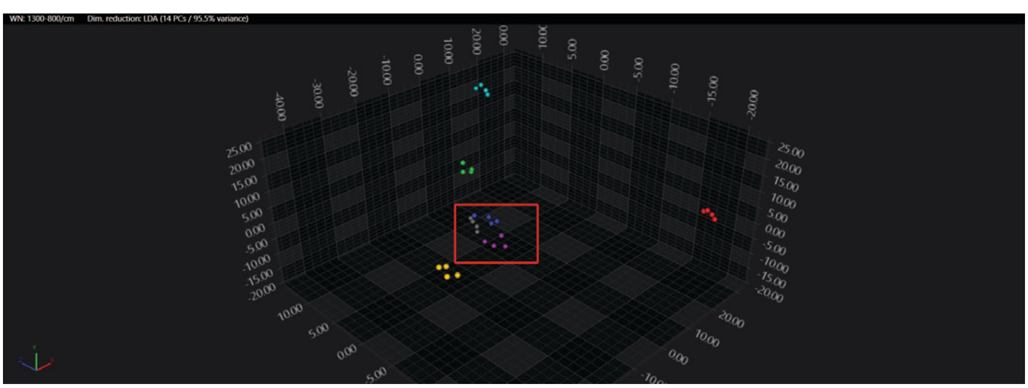


Figure 3

A: IR Biotyper cluster analysis dendrogram of isolates from the patient, family members, and home environment.



B: 2D scatter plot of IR Biotyper clustering for the isolates.



C: 3D scatter plot of IR Biotyper clustering for the isolates.

KW1 is the *Campylobacter jejuni* detected in the patients. IR Biotyper showed that it was homologous to strains KW2 and KW3 isolated from family members and the home environment.

Strong potential in outbreak prevention

The rapid typing technology of the IR Biotyper holds promise in routine disease control, where the first line of defense institutions face severe challenges including a lack of detection resources and specialized technical expertise.

The IR Biotyper offers ease of use in a cost-effective, high throughput screening solution, enabling rapid and accurate foodborne disease detection and tracing results, even in remote areas. The Jiangxi CDC's future focus is on expanding the IR Biotyper's application scope to include more foodborne pathogens and serotypes. The team plans to collect extensive strain samples to build a more comprehensive database, refine algorithm models, and enable precise identification of more complex pathogens, providing broader technical support for epidemic prevention and, ultimately, protecting public health.

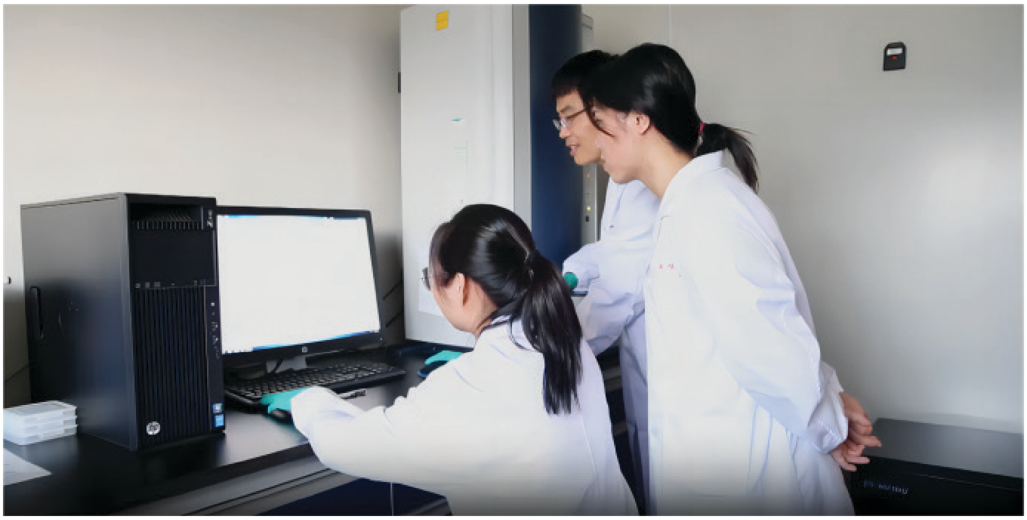


Figure 4
The Jiangxi CDC team discussing MALDI Biotyper results.

References

[1] Elbehiry, Ayman, et al. 2023. "An Overview of the Public Health Challenges in Diagnosing and Controlling Human Foodborne Pathogens." Vaccines 11 (4): 725.
https://doi.org/10.3390/vaccines11040725

[2] World Health Organization. "Research and development technology roadmap for invasive non-typhoidal *Salmonella* vaccines against invasive disease." 30 May 2025. Accessed 26 September 2025.
https://www.who.int/publications/i/item/9789240110212

[3] BS EN ISO 6579-1:2017+A1:2020. Microbiology of the Food Chain. Horizontal Method for the Detection, Enumeration and Serotyping of *Salmonella*. Detection of *Salmonella* spp. British Standards Institution, 2017. Amendment 1, 2020.
https://www.iso.org/standard/56712.html

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