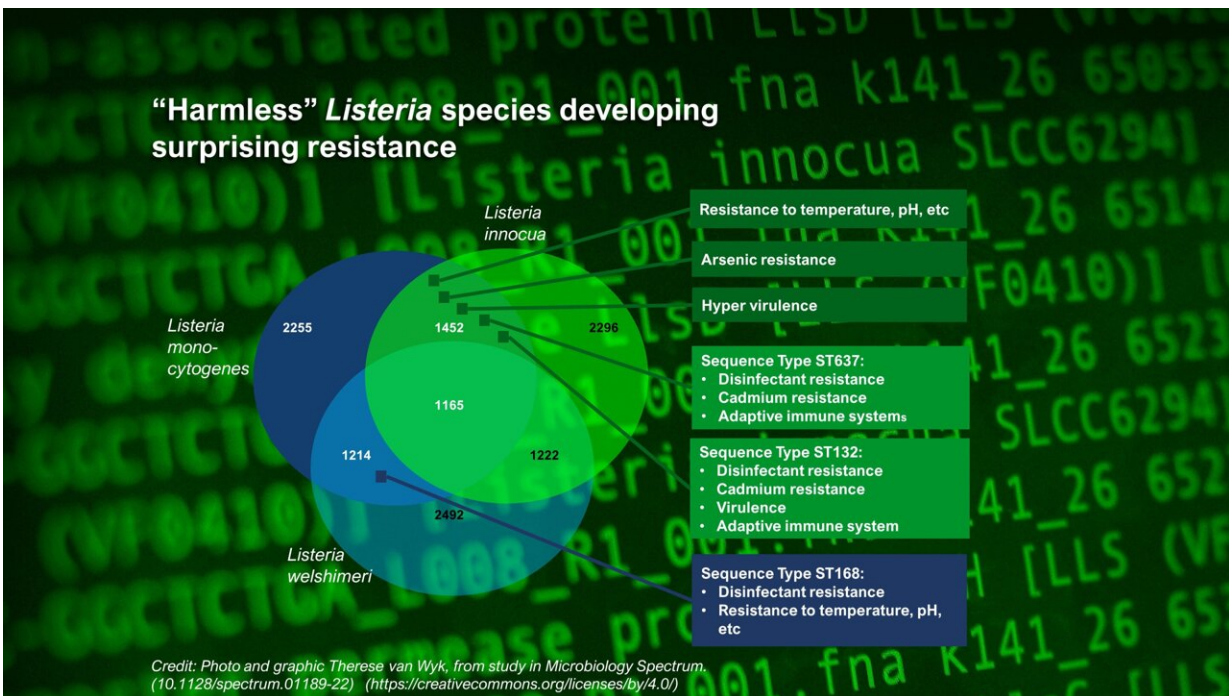


# 'Harmless' Listeria species developing pathogenic resistance

December 5 2022



Food-borne bacteria *Listeria innocua* and *L. welshimeri* are often regarded as harmless, compared to the deadly *Listeria monocytogenes*. But both these species are developing an unexpected number of harmful characteristics that can make food safety measures more difficult to maintain, shows a Whole Genome Sequencing study from South Africa. Some strains analysed have virulence genes identical to that of *L. monocytogenes*. Credit: Photo of data and graphic by Therese van Wyk. Study published in *Microbiology Spectrum* by Mafuna et al. (10.1128/spectrum.01189-22) ([creativecommons.org/licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/))

In the food processing industry, the deadly bacteria *Listeria monocytogenes* is monitored closely. Not only can the bacteria make people extremely ill, it is known to be developing resistance to food safety measures around the world.

However, two "harmless" species of *Listeria* are also developing a surprising number of characteristics potentially harmful to humans.

A [whole-genome sequencing](#) study in South Africa, from a team of researchers with first author Dr. Thendo Mafuna at the University of Johannesburg, shows some of the changing characteristics of *Listeria* found in the country.

The study shows that *Listeria innocua* strains are developing resistance to temperature, pH, dehydration and other stresses; as well as hypervirulence genetically identical to that of *Listeria monocytogenes*.

Some strains of *L. innocua* and *L. welshimeri* in the study show all three genes for resistance to a widely used disinfectant, from the quaternary ammonium compound (QAC or QUAT) group of chemicals.

Two strains of *L. innocua* they analyzed have developed three or more concerning pathogenic characteristics, including CRISPR CAS-type adaptive immune systems.

The two non-pathogenic strains of *Listeria* were sampled in raw, dried and processed meats at commercial food processing facilities in the country.

The study confirms other research showing growing resistance in non-pathogenic *Listeria* species in other parts of the world.

## “Harmless” *Listeria* species developing surprising resistance

Non-pathogenic food-borne bacteria *Listeria innocua* and *L. welshimeri* are generally regarded as much less of a problem than the deadly *Listeria monocytogenes*. However, researchers from the University of Johannesburg show that *L. innocua* and *L. welshimeri* strains from meat processing facilities in South Africa are acquiring an unexpected number of harmful characteristics, genetically similar to those in *L. monocytogenes*, that can make food safety more difficult to maintain.

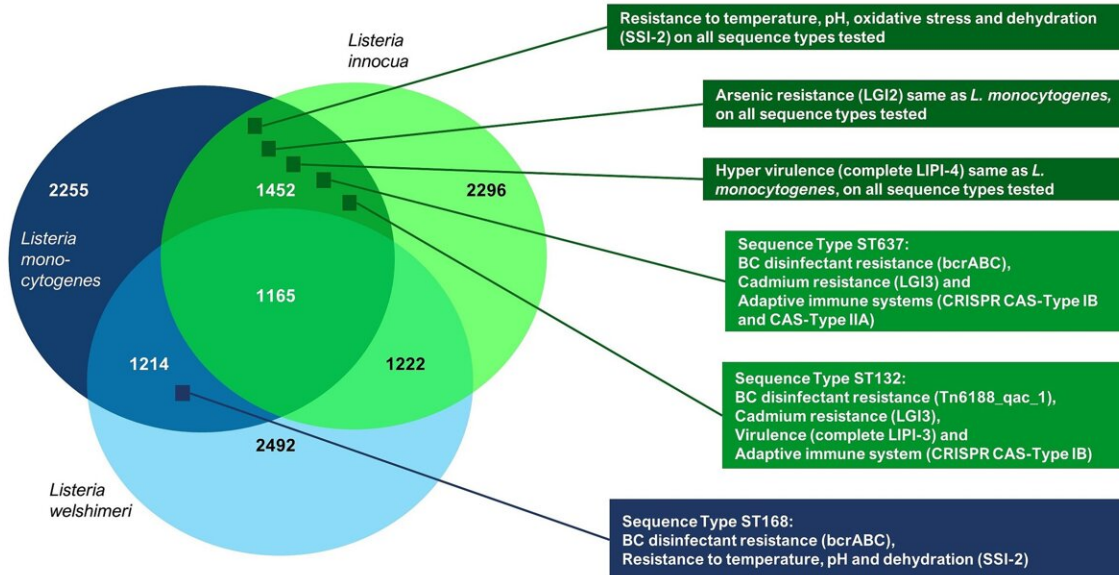


Diagram showing how many core genes for harmful characteristics relevant to food processing and safety occur in one or more of *Listeria* species. In this study, *L. innocua* and *L. welshimeri* were analyzed. The annotations in the shared areas between *L. innocua* and *L. monocytogenes* indicate genes that are known to be found in *L. monocytogenes* also. Block annotations indicate Benzalkonium chloride (BC) resistance genes, stress survival islets (SSI), virulence factors (LIPI), and CRISPR-cas adaptive immune systems found in one or more Sequence Types in a *Listeria* bacterium species in this study.

Credit: Therese van Wyk, from study in *Microbiology Spectrum*. (10.1128/spectrum.01189-22) (<https://creativecommons.org/licenses/by/4.0/>)

Food-borne bacteria *Listeria innocua* and *L. welshimeri* are often regarded as harmless, compared to the deadly *Listeria monocytogenes*. But both these species are developing an unexpected number of harmful characteristics that can make food safety measures more difficult to maintain, shows a whole-genome study from South Africa. Some strains analysed have virulence genes identical to that of *L. monocytogenes*. Credit: Therese van Wyk. Study published in *Microbiology Spectrum* by Mafuna et al. (10.1128/spectrum.01189-22) ([creativecommons.org/licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/))

## Shared genes with pathogenic species

"The *Listeria innocua* that we tested has some of the genes that are also

found in pathogenic *Listeria monocytogenes*," says Dr. Thendo Mafuna. Mafuna is from the Department of Biochemistry at the University of Johannesburg.

These shared genes between *L. innocua* and *L. monocytogenes* are also responsible for disease in humans; and stress tolerance such as resistance to the disinfectant Benzalkonium chloride (BC or BAC).

Research from others has shown that though Listeriosis is rarely caused by *L. innocua*, it does happen more often in people with compromised immune systems, he adds.

Benzalkonium chloride (BAC) is a member of a group of chemicals called Quaternary ammonium compounds, or QUATs. Quats are found in many common disinfectant products. They have been shown to be highly effective at killing bacteria, fungi and viruses.

All the *L. innocua* strains they tested also had the complete LIPI-4 hypervirulence gene sequence, which can cause disease in humans, he says. The LIPI-4 sequence they found in *L. innocua* is identical to that found in pathogenic *L. monocytogenes*, as recorded by the Pasteur Institute in Paris, France.

## **From raw, dried and processed meats**

The samples and isolates analyzed in this study were collected between 2014 and 2019 by the South African Government's Department of Agriculture, Land Reform and Rural Development (DALRRD). These were submitted to the Agricultural Research Council (ARC) at Onderstepoort Veterinary Research SA for analysis.

In total, 258 isolates from butcheries, abattoirs, [retail outlets](#), cold stores and processing facilities all over the country were studied. Of these, 38

were found to be nonpathogenic *L. innocua*; and another three isolates found to be nonpathogenic *L. welshimeri*.



Dr Thendo Mafuna from the Department of Biochemistry at the University of Johannesburg (UJ). In this composite photo, Dr Mafuna is in one of the UJ Biochemistry laboratories, and facing genetic data for *Listeria innocua*. Food-borne bacteria *Listeria innocua* and *L. welshimeri* are often regarded as harmless, compared to the deadly *Listeria monocytogenes*. But both these species are developing an unexpected number of harmful characteristics that can make food safety measures more difficult to maintain. Credit: Photo of data and Dr Mafuna by Therese van Wyk, University of Johannesburg.

The isolates came from raw whole, raw processed, dried, and processed cooked, beef, chicken and pork meats. Dr. Itumeleng Matle at the Bacteriology Division, ARC in Onderstepoort did the microbiological analysis of *Listeria* isolation and identification.

The Whole Genome Sequencing (WGS) was done by Dr. Rian E. Pierneef at the ARC's Biotechnology Platform at Onderstepoort. Mafuna then compared the genome sequences with those recorded by the Pasteur Institute, in Paris, France; and performed the analysis for the study.

## On the lookout

"We need to look at our own facilities in South Africa to really see what is happening. Our analyses of these bacteria can help us predict which sequence types to be on the look out for," says Mafuna.

It is the number of harmful characteristics that the *L. innocua* strains share with *L. monocytogenes* that is concerning, he adds.

Food processors need to look out for *Listeria innocua* because it is becoming resistant to disinfectants that are used in industry to get rid of them. It would also be helpful to try different types of disinfectants to surfaces, he says. Switching from one type to another may prevent or delay the bacteria developing resistance to one type of disinfectant.

"Big industrial food processors may want to investigate how efficient BC or quat disinfectants are in their facilities. This can be done by taking swabs before cleaning and again after cleaning, culturing those, to see how well the [disinfectant](#) regimes are working," says Mafuna.

The study is published in the journal *Microbiology Spectrum*.

**More information:** T. Mafuna et al, Comparative Genomics of *Listeria* Species Recovered from Meat and Food Processing Facilities, *Microbiology Spectrum* (2022). [DOI: 10.1128/spectrum.01189-22](https://doi.org/10.1128/spectrum.01189-22)

Provided by University of Johannesburg

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