

# Surveillance of AMR in *Escherichia coli* on Raw Fresh Beef and Pork Meat in Retail Sale in Northern Ireland in 2023

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## FSA Research and Evidence

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- Mandatory anonymised reporting (without product details) under [EU regulation 2020/1729](#) for the monitoring and reporting of antimicrobial resistance (AMR) in zoonotic and commensal bacteria has been submitted to the EU for antimicrobial resistant *Escherichia coli* (*E. coli*) isolated from fresh pork and beef purchased for retail sale in NI from September to December 2023.
- In this survey 96 pork and 98 beef fresh retail meat samples were tested for AMR *E. coli* according to EU guidelines.
- No isolates were resistant to last line antibiotics, including colistin and carbapenems.
- The prevalence of AMR *E. coli* was low (3%) from 194 raw fresh beef and pork samples.
- The risk of acquiring AMR related infections through the handling and consumption of retail contaminated meats is very low, provided that good hygiene and cooking practices are followed when handling raw meats.

## 1. Introduction

AMR microorganisms are increasingly being recognised as a global problem. Whilst it is a natural process, the extensive use of antimicrobials in humans and animals has been a significant driving force in its development. Antimicrobials are used in the livestock industry to prevent and control bacterial disease. The use of subtherapeutic levels of antibiotics in animal feed (as growth promoters) since the 1950's has caused an expansion of the pool of AMR bacteria. In 2006 the use of these was banned in the EU and the UK ([WHO, 2023](#)).

*E. coli* is a normal inhabitant of the mammalian gut (termed a commensal) and most isolates do not cause observable clinical disease in healthy animals or humans ([WHO, 2018](#)). However, commensal bacteria can be AMR gene reservoirs. Horizontal gene transfer among bacteria allows them to exchange their genetic material, including antibiotic resistance genes. *E. coli* isolates are therefore useful 'indicators' of AMR. They are ubiquitous in animals and they allow us to monitor the presence of AMR typically circulating in food producing animals. If bacteria possess a resistance to three or more different classes of antibiotics, they are called multidrug resistant (MDR). MDR bacteria pose a health risk because fewer therapeutic agents are active against them. This is a particular concern if the MDR includes resistance to certain classes of antibiotics (such as the carbapenems), which are used to treat severe bacterial infections when other treatment options are ineffective ([WHO, 2017](#)).

One of the main objectives within the [FSA's Strategy for 2022-2027](#) is to ensure that 'food is safe'. Addressing the public health threat posed by AMR is a national strategic priority for the UK and led to the Government publishing both a [20-year vision of AMR](#) and a [5-year \(2024-2029\) AMR National Action Plan \(NAP\)](#). This survey will provide continued monitoring for *E. coli* from retail meats and fits into the [Northern Ireland AMR Action Plan](#), which aims to promote relevant research and to ensure that policy and practice are informed by this. The continued surveillance of AMR bacteria in humans, environments and food producing animals is crucial to monitor and understand if these meats pose a risk to animal public health, in relation to AMR and will allow future monitoring of trends over time. The FSA is responsible for the monitoring and reporting to the European Union (EU) of AMR from fresh meats at retail sale in Northern Ireland (NI) under [\(EU\) 2020/1729](#) and [Article 9\(1\) of Directive 2003/99/EC](#).

## 2. Material and methods

The FSA commissioned an [AMR survey in beef and pork in 2023, 2025 and 2027 and chicken and turkey meats in 2024 and 2026 collected at retail sale in NI](#) under [\(EU\) 2020/1729](#). The sampling methodology and analytical methods met EU specifications to enable data comparability.

This survey collected 96 pork and 98 beef fresh meat samples on retail sale in NI from September to December 2023. The prevalence of commensal *E. coli* was tested from all 194 retail meat samples. Selective agars and biochemical testing were used to confirm the identity of all bacterial isolates as *E. coli*. Analysis involved the initial isolation and enrichment of *E. coli* from all meat samples, prior to testing for the production of Extended Spectrum Beta Lactamases (ESBLs), AmpC  $\beta$ -Lactamases (AmpC) and Carbapenemases (CP) enzymes. The AMR phenotype was determined using a standard microbroth dilution method with European Committee on

Antimicrobial Susceptibility Testing (EUCAST) thresholds for resistance and concentration ranges for (up to 25) antimicrobial substances according to EU decision [\(EU\) 2020/1729](#). Five confirmed AMR resistant *E. coli* isolates had Whole Genome Sequencing (WGS) performed on them, including In-silicon Multi-locus sequence typing (MLST) and AMR analyses using draft genome assemblies according to EU guidelines. All genes and plasmids of AMR and virulence interest had at least 95% identity. All DNA sequences were uploaded to the European Nucleotide Archive (ENA) browser: [PRJEB72200](#).

## Tables 1-3

Table 1. Antimicrobial resistant (AMR) resistance genes and AMR phenotype with National Center for Biotechnology Information (NCBI) Accession numbers from the five *Escherichia coli* isolates from 194 fresh retail beef and pork samples from Northern Ireland in 2023. The study number isolate identity (ID), Multi-locus sequence Type Identity (MLST ID) and MLST lineage are also included.

| Isolate ID       | MLST ID | MLST Lineage | AMR resistance gene | AMR phenotype                                                                                                       | NCBI Accession Number |
|------------------|---------|--------------|---------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------|
| RM-NI-131-CTX-23 | 23      | B1           | aadA1               | Spectinomycin, Streptomycin                                                                                         | JX185132              |
|                  |         |              | aadA1               | Spectinomycin, Streptomycin                                                                                         | JQ414041              |
|                  |         |              | blaCTX-M-1          | Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone, Piperacillin, Ticarcillin       | DQ915955              |
|                  |         |              | sul1                | Sulfamethoxazole                                                                                                    | U12338                |
|                  |         |              | tet(A)              | Doxycycline, Tetracycline                                                                                           | AJ517790              |
| RM-NI-159-CTX-23 | 4981    | A            | aadA1               | Spectinomycin, Streptomycin                                                                                         | JQ414041              |
|                  |         |              | aadA2b              | Spectinomycin, Streptomycin                                                                                         | D43625                |
|                  |         |              | aph(6)-Id           | Streptomycin                                                                                                        | M28829                |
|                  |         |              | aph(3'')-Ib         | Streptomycin                                                                                                        | AF321551              |
|                  |         |              | aadA5               | Spectinomycin, Streptomycin                                                                                         | AF137361              |
|                  |         |              | aph(3')-Ia          | Kanamycin, Neomycin, Neomycin, Kanamycin, Lividomycin, Paromomycin, Ribostamycin, Unknown Aminoglycoside, Kanamycin | V00359                |
|                  |         |              | blaCTX-M-15         | Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone,                                 | AY044436              |

| Isolate ID        | MLST ID | MLST Lineage | AMR resistance gene | AMR phenotype                                                                                                 | NCBI Accession Number |
|-------------------|---------|--------------|---------------------|---------------------------------------------------------------------------------------------------------------|-----------------------|
|                   |         |              |                     | Piperacillin, Ticarcillin                                                                                     |                       |
|                   |         |              | blaTEM-1B           | Amoxicillin, Ampicillin, Cephalothin, Piperacillin, Ticarcillin                                               | AY458016              |
|                   |         |              | cmlA1               | Chloramphenicol                                                                                               | M64556                |
|                   |         |              | sul3                | Sulfamethoxazole                                                                                              | AJ459418              |
|                   |         |              | sul2                | Sulfamethoxazole                                                                                              | HQ840942              |
|                   |         |              | tet(B)              | Doxycycline, Tetracycline, Minocycline                                                                        | AF326777              |
|                   |         |              | dfrA17              | Trimethoprim                                                                                                  | FJ460238              |
| RM-NI-181-CTX-23  | 2179    | AxB1         | aph(6)-Id           | Streptomycin                                                                                                  | M28829                |
|                   |         |              | aph(3'')-Ib         | Streptomycin                                                                                                  | AF321551              |
|                   |         |              | blaTEM-1B           | Amoxicillin, Ampicillin, Cephalothin, Piperacillin, Ticarcillin                                               | AY458016              |
|                   |         |              | blaCTX-M-65         | Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone, Piperacillin, Ticarcillin | EF418608              |
|                   |         |              | floR                | Chloramphenicol, Florfenicol                                                                                  | AF118107              |
|                   |         |              | qnrS2               | Ciprofloxacin                                                                                                 | DQ485530              |
|                   |         |              | sul2                | Sulfamethoxazole                                                                                              | AY034138              |
|                   |         |              | tet(A)              | Doxycycline, Tetracycline                                                                                     | AF534183              |
| RM-NI-058-CTX-23  | 69      | D            | aph(6)-Id           | Streptomycin                                                                                                  | M28829                |
|                   |         |              | aph(3'')-Ib         | Streptomycin                                                                                                  | AF321551              |
|                   |         |              | blaCTX-M-15         | Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone, Piperacillin, Ticarcillin | AY044436              |
|                   |         |              | blaTEM-1B           | Amoxicillin, Ampicillin, Cephalothin, Piperacillin, Ticarcillin                                               | AY458016              |
|                   |         |              | qnrS1               | Ciprofloxacin                                                                                                 | AB187515              |
|                   |         |              | sul2                | Sulfamethoxazole                                                                                              | AY034138              |
|                   |         |              | tet(A)              | Doxycycline, Tetracycline                                                                                     | AJ517790              |
|                   |         |              | aph(6)-Id           | Streptomycin                                                                                                  | M28829                |
| RM-NI-094-CTX-23: | 328     | None         | dfrA14              | Trimethoprim                                                                                                  | KF921535              |
|                   |         |              | aadA17              | Spectinomycin, Streptomycin                                                                                   | FJ460181              |
|                   |         |              | blaTEM-52B          | Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime,                                        | AF027199              |

| Isolate ID | MLST ID | MLST Lineage | AMR resistance gene | AMR phenotype                             | NCBI Accession Number |
|------------|---------|--------------|---------------------|-------------------------------------------|-----------------------|
|            |         |              |                     | Ceftriaxone,<br>Piperacillin, Ticarcillin |                       |
|            |         |              | lnu(F)              | Lincomycin                                | EU118119              |

Table 2. Identified Antimicrobial resistant (AMR) plasmids with National Center for Biotechnology Information (NCBI) Accession numbers present in the five *Escherichia coli* isolates isolated from 194 fresh retail beef and pork samples from Northern Ireland in 2023. The study number isolate identity (ID) and isolate Multi-locus sequence Type Identity (MLST ID) are also included.

| Isolate ID       | MLST ID | Plasmid                | NCBI Accession Number |
|------------------|---------|------------------------|-----------------------|
| RM-NI-131-CTX-23 | 23      | Col(MG828)             | NC008486              |
|                  |         | IncFIB(AP001918)       | AP001918              |
|                  |         | IncFIC(FII)            | AP001918              |
|                  |         | IncFII                 | AY458016              |
|                  |         | IncI1-I(Alpha)         | AP005147              |
|                  |         | IncX1                  | EU370913              |
|                  |         | IncX4                  | CP002895              |
| RM-NI-159-CTX-23 | 4981    | Col(pHAD28)            | KU674895              |
|                  |         | Col8282                | DQ995352              |
|                  |         | IncFIB(AP001918)       | AP001918              |
|                  |         | IncFII(pAMA1167-NDM-5) | CP024805              |
|                  |         | IncQ1                  | M28829                |
|                  |         | p0111                  | AP010962              |
| RM-NI-181-CTX-23 | 2179    | IncFIB(AP001918)       | AP001918              |
|                  |         | IncFIC(FII)            | AP001918              |
| RM-NI-058-CTX-23 | 69      | IncY                   | K02380                |
| RM-NI-094-CTX-23 | 328     | Col(MG828)             | NC008486              |
|                  |         | IncFII(29)             | CP003035              |
|                  |         | IncX1                  | EU370913              |

Table 3. Virulence, acid, and metal genes from the five *Escherichia coli* isolates from 194 fresh retail beef and pork samples from Northern Ireland in 2023. The study number isolate identity (ID), Multi-locus sequence Type Identity (MLST ID) and MLST lineage are also included.

| Isolate ID       | MLST ID | MLST Lineage | Virulence genes                                                                                                 | Acid genes                                                                                      | Metal genes                  |
|------------------|---------|--------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------|
| RM-NI-131-CTX-23 | 23      | B1           | cvaC, espX1, fdeC, iroB, iroC, iroD, iroE, iroN, iss, iucA, iucB, iucC, iucD, iutA, lpfA, mchF, tsh, ybtP, ybtQ | merC, merP, merR, merT                                                                          | emrE, qacEdelta1, ymgB       |
| RM-NI-159-CTX-23 | 4981    | A            | emrE, qacL                                                                                                      | cvaC, espX1, fdeC, iroB, iroC, iroD, iroE, iroN, iss, iucA, iucB, iucC, iucD, iutA, mchF, ybtP, | ymgB, merC, merP, merR, merT |

| Isolate ID       | MSLT ID | MLST Lineage | Virulence genes                                                                                | Acid genes | Metal genes      |
|------------------|---------|--------------|------------------------------------------------------------------------------------------------|------------|------------------|
|                  |         |              |                                                                                                | ybtQ       |                  |
| RM-NI-181-CTX-23 | 2179    | AxB1         | espX1, fdeC, iroB, iroC, iroD, iroE, iroN, iss, iucA, iucB, iucC, iucD, iutA, lpfA, ybtP, ybtQ | emrE       | ymgB             |
| RM-NI-058-CTX-23 | 69      | D            | air, eilA, espX1, fdeC, iss, lpfA, ybtP, ybtQ                                                  | ymgB       | arsD             |
| RM-NI-094-CTX-23 | 328     | None         | cif, eae, espA, espB, espF, espJ, espX1, fdeC, lpfA, nleA, nleB2, nleC, tir                    | ymgB       | terD, terW, terZ |

### 3. Results

- No isolates were resistant to last line antibiotics, including colistin and carbapenems.
- The prevalence of AMR *E. coli* was low (3%) from raw fresh beef and pork samples.
- Five isolates had confirmed ESBL resistance, one of which also had additional confirmed AmpC resistance. All of these isolates had resistance to Ampicillin, Cefepime, Cefotaxime and Sulfamethoxaoles. The isolate with both ESBL & AmpC resistance also displayed Cefoxitin resistance
- [Table 1](#) above details the identity of AMR genes, [Table 2](#) details plasmids of AMR interest, and [Table 3](#) details virulence, acid and metal genes of interest from all five AMR *E. coli* isolates.

### 4. Discussion

In conclusion, this study indicated a low prevalence of AMR *E. coli* resistance from 96 pork and 98 beef fresh meat samples on retail sale in NI from September to December 2023. The risk of acquiring AMR related infections through the handling and consumption of retail contaminated meats is very low, provided that good hygiene and cooking practices are followed when handling raw meats ([FSA, 2024](#)).

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## Liability statement

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