High Prevalence of Extended-Spectrum-Cephalosporin-Resistant
Enterobacteriaceae in Poultry Meat in Switzerland: Emergence of
CMY-2- and VEB-6-Possessing Proteus mirabilis

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The spread of extended-spectrum-cephalosporin-resistant (ESC-R) Escherichia coli in poultry meat is a serious concern (1–3). However, data regarding this problem in Switzerland are lacking. Moreover, the role played in this matter by other Enterobacteriaceae remains undetermined.

We explored the prevalence of extended-spectrum-β-lactamase (ESBL)- and plasmid-mediated-AmpC (pAmpC)-possessing Enterobacteriaceae as contaminants of raw poultry meat retailed in Bern, Switzerland. Twenty samples were purchased on various days during November and December 2012 in three grocery stores (Table 1). Ten grams of meat was incubated overnight in LB broth, and then 50 μl was plated on plates containing selective chromID ESBL agar, MacConkey agar plus ceftazidime (2 μg/ml), and Drigalski agar plus cefotaxime (1.5 μg/ml) (bio-Mérieux). Colonies were identified by MALDI-TOF MS (matrix-assisted laser desorption ionization–time of flight mass spectrometry; Bruker). ESC-R Enterobacteriaceae were characterized using phenotypic and molecular methods as previously done (4–7) (see Table S1 in the supplemental material).

Fourteen samples (70%) contained ESC-R E. coli (n = 11), ESC-R P. mirabilis (n = 2), or both resistant species (n = 1) (Table 1). ESC-R E. coli strains found in meat originating from Switzerland possessed blaCTX-M-1 and blaCMY-2, whereas those detected in meat imported from other countries harbored blaSHV-12, blaTEM-52, or blaCMY-2. Several ESC-R E. coli isolates belonged to the same sequence type (ST), but pandemic clones (e.g., ST131) often responsible for human infections were not found (8, 9). The recorded high prevalence of ESC-R E. coli (60%) was consistent with prevalences reported in other countries (1–3). However, we note that in Switzerland, CTX-M-1- and CMY-2-producing E. coli strains are common colonizers of food animals and may also cause human infections (4, 6, 10).

More intriguing was the detection of ESC-R P. mirabilis that grew in MacConkey-ceftazidime and Drigalski-cefotaxime plates. In particular, one meat sample imported from Austria harbored blaCMY-2, whereas two from an unspecified European country carried blaVEB-6. These samples came from the same store and same packing plant but were wrapped on different dates.

CMY-2-positive P. mirabilis isolates are commonly found in humans (11), but only unique VEB-6-possessing P. mirabilis isolates had been previously reported as responsible for infection in France, Oman, and Australia (7, 12, 13). In our isolates, blaVeB-6 was situated in an ~17-kb class I integron which also carried aacA4, aadB, dfrA1, sul1, tet(A), and qnrA1 resistance genes and had a nucleotide sequence identical to that found in the human VEB-6-positive P. mirabilis isolate (VB1248) reported in France (12). Both VEB-6-positive P. mirabilis isolates also possessed a previously reported class II integron of ~4.6 kb containing dfrA1, sat2, and aadA1 resistance genes (GenBank no. DQ268533) and a single ~50-kb IncP plasmid. Electroporation experiments failed to transfer blaVeB-6, suggesting the chromosomal location of the integron. By repetitive extragenic palindromic PCR (rep-PCR), the two VEB-6-positive P. mirabilis isolates were identical to each other and showed 94% genomic identity with VB1248. Based on these results, we investigated the possible presence of VEB-6-positive P. mirabilis among 484 human isolates identified in Bern during 2011–2012, and we identified only four CMY-2–positive P. mirabilis isolates which were not clonally related to those found in poultry meat (see Fig. S1 in the supplemental material).

This is the first report of blaVeB-possessing P. mirabilis in a non-human clinical setting and the first description of ESBL- and pAmpC-positive P. mirabilis strains in the food chain. Our findings emphasize that not only ESC-R E. coli but also other species are responsible for the spread of multidrug-resistant mobile genetic elements in the raw meat. CMY-2- and VEB-6-positive P. mirabilis strains might represent an additional group of life-threatening pathogens that can be transmitted through the food chain to humans (8).
The natural text is not clearly legible due to the image quality. However, it appears to be a summary or analysis of various isolates and their antibiotic susceptibilities. It mentions the presence of specific enzymes and integrons, as well as the results of isoelectric focusing and antibiotic susceptibility testing.

**Table 1:** Phenotypic and molecular characteristics of the bacteria and plasmid-encoded β-lactamase genes and integrons found in poultry mead revisited in Europe during the study period.

<table>
<thead>
<tr>
<th>Species</th>
<th>E. coli</th>
<th>C. coli</th>
<th>P. mirabilis</th>
<th>A. calcoaceticus</th>
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<tr>
<td><strong>Antibiotic Susceptibility</strong></td>
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<td>Amikacin (AMK)</td>
<td>S</td>
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<td>Ertapenem (ERT)</td>
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<td>Piperacillin-Tazobactam (PCT)</td>
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<td>Cefepime (FEP)</td>
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<td>Cotrimoxazole (SXT)</td>
<td>S</td>
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<td>Colistin (COL)</td>
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<tr>
<td>Tazobactam (TGP)</td>
<td>S</td>
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**Plasmid Classes:**

- CTX-M-1
- SHV-12
- TEM-1
- X1

**Integron Classes:**

- I1
- B1ST155
- II
- III

**Antimicrobial Resistance:**

- TEM-1 (pI 5.4)
- VEB-6 (pI 7.2)

**Analysis:**

- Both isolates possessed the following non-β-lactamase genes: sul1, sul2, aphA, and bla.

**Conclusions:**

- The isolates were resistant to various antibiotics, indicating the need for further study to understand the mechanisms of resistance.
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REFERENCES