Antibiotic Resistance of *Erysipelothrix rhusiopathiae* Isolated from Pigs with Chronic Swine Erysipelas

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The susceptibility of 258 isolates of *Erysipelothrix rhusiopathiae* from slaughtered pigs affected with chronic erysipelas in Japan to antimicrobial agents was determined. A total of 111 (43.0%) strains showed resistance to erythromycin, oleandomycin, oxytetracycline, or dihydrostreptomycin. Plasmids were not detected. This is the first report of resistance of *E. rhusiopathiae* to these antibiotics.

* Erysipelothrix rhusiopathiae (insidiosa) * is a causative agent of swine erysipelas, which causes great economic loss in pig production. Human *E. rhusiopathiae* infection has also been reported (2, 4, 12, 14). Antibiotics, especially penicillins, have been widely used for the treatment of this disease. However, in Japan, pigs are usually fed food containing various antibiotics, mainly tetraclines and macrolides, for the purpose of growth stimulation. It seems, therefore, that long-term administration of antibiotics will give a selective advantage to antibiotic-resistant strains of *E. rhusiopathiae*. This paper deals with the antibiotic resistance in *E. rhusiopathiae* strains isolated from pigs in Japan.

A total of 258 strains of *E. rhusiopathiae* were submitted for assay of antibiotic susceptibility. They were isolated from cases of chronic swine erysipelas in slaughterhouses from October 1980 to December 1982. Infections associated with the isolates included arthritis (148 cases), lymphenitis (65 cases), endocarditis (30 cases), and urticaria (15 cases). Antimicrobial agents studied were penicillin (PC-G), ampicillin (APC), erythromycin (EM), oleandomycin (OM), oxytetracycline (OTC), chloramphenicol (CP), dihydrostreptomycin (DSM), kanamycin (KM), and sulfadimethoxine (SDM). MICs were determined by an agar dilution method (5). A 10−2 dilution of an overnight tryptic soy broth culture was inoculated by microplanter (Ebara Works, Tokyo, Japan) onto Mueller-Hinton agar containing serial twofold dilutions of the test antibiotic. The plates were incubated at 37°C for 48 h. The MIC was defined as the lowest concentration of antimicrobial agent that prevented macroscopic growth. Isolates were serotyped by using a modification of the agar gel diffusion method of Kucsera (11).

MICs are shown in Table 1. All of the strains were highly susceptible to PC-G and APC (MIC, 0.025 to 0.1 μg/ml) and moderately susceptible to CP (MIC, 1.56 to 25 μg/ml). KM and DSM showed no activity against the strains (MICs, >100 and >400 μg/ml, respectively). MICs of EM, OM, OTC, and DSM presented two distribution peaks. The MIC breakpoints of strains resistant to EM, OM, OTC, and DSM were assumed to be 0.78, 3.13, 3.13, and 100 μg/ml, respectively. The frequencies of isolation of *E. rhusiopathiae* strains resistant to each drug were as follows: OTC (42.6%), DSM (17.4%), EM (5.8%), and OM (5.0%).

The relationship between antimicrobial resistance patterns, sources, and serotypes of isolates is shown in Table 2. A total of 111 (43.0%) strains were resistant to EM, OM, OTC, or DSM. Six different resistance patterns were found. Strains resistant only to OTC (25.6%) were most frequent, followed by those resistant to OTC and DSM (10.8%), EM, OM, OTC, and DSM (4.6%), EM, OTC, and DSM (1.2%), OM, OTC, and DSM (0.4%), and DSM (0.4%). In the *E. rhusiopathiae* strains isolated from cases of endocarditis, the frequency of resistance was significantly (P < 0.05, by Fisher’s exact test) lower than in the isolates from other infections. Triple resistance and quadruple resistance were found only in isolates from cases of arthritis and lymphenitis. Of the 111 resistant strains, 104 (93.7%) belonged to serotype 2. Isolation of plasmid DNA was attempted by the method of Wombol et al. (15) and Kado and Liu (6), except for the use of sodium lauroyl sarcosinate (6%) in the procedure of bacteriolyis. However, we could not detect any plasmid in strains showing the various resistance patterns (data not shown).

The present results on susceptibility of *E. rhusiopathiae* strains to PC-G, APC, CP, KM, and SDM are in general agreement with those reported previously by others (1, 3, 7–10, 13), indicating that penicillins remain the antibiotics of choice for the treatment of swine erysipelas. It should be noted, however, that 43% of *E. rhusiopathiae* strains examined showed resistance to EM, OM, OTC, or DSM. This is the first report on resistant strains of *E. rhusiopathiae* of porcine origin. Although the detailed mechanisms of antibiotic resistance were not established, plasmid DNA in resistant strains was not found. In any case, frequent use of tetraclyclines and macrolides for pig production will undoubtedly give a selective advantage to antibiotic-resistant strains of *E. rhusiopathiae*.

Our results also showed that most of the resistant *E. rhusiopathiae* strains belonged to serotype 2. Further epidemiological studies are necessary to clarify this correlation.

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TABLE 1. Susceptibility of 258 isolates of *E. rhusiopathiae* to antimicrobial agents

| Drug | 0.025 | 0.05 | 0.1 | 0.2 | 0.39 | 0.78 | 1.56 | 3.13 | 6.25 | 12.5 | 25 | 50 | 100 | >100 | >400 |
|------|-------|------|-----|-----|------|------|------|------|------|------|----|----|-----|------|------|
| PC-G* | 23    | 213  | 22  |     |      |      |      |      |      |      |    |    |     |      |      |
| APC  | 23    | 162  | 73  |     |      |      |      |      |      |      |    |    |     |      |      |
| EM   | 2     | 54   | 177 | 10  |      |      |      |      |      |      |    |    |     |      |      |
| OM   |       |      |     | 6   | 10   | 174  | 55   | 5    |     |      |    |    |     |      | 0.78 |
| OTC  |       |      |     | 2   | 3    | 87   | 56   | 5    | 15   |      |    |    |     |      | 3.13 |
| CP   |       |      |     | 11  | 16   | 205  | 23   | 3    |     |      |    |    |     |      |      |
| DSM  |       |      |     | 173 | 24   | 7    | 4    | 45   |     |      |    |    |     |      | 100  |
| KM   |       |      |     | 258 |      |      |      |      |      |      |    |    |     | 258  |      |

| MIC (µg/ml) | No. of resistant strains (%) |
|-------------|-------------------------------|
| 0.78        | 15 (5.8)                      |
| 3.13        | 13 (5.0)                      |
| 100         | 45 (17.4)                     |

* Units per milliliter.

TABLE 2. Relationship between resistance patterns, sources, and serotypes of 258 *E. rhusiopathiae* isolates

| Resistance pattern* | Sourceb | Serotype | Total (%) |
|---------------------|---------|----------|-----------|
|                     | A       | L        | E        | U        | 1a      | 1b      | 2       | Other   |         |
| EM, OMC, OTC, DSM  | 5       | 7        | 0       | 0       | 0       | 12      | 0       | 0       | 12 (4.6) |
| EM, DSM            | 2       | 1        | 0       | 0       | 0       | 3       | 0       | 1       | 3 (1.2)  |
| OMC, DSM           | 1       | 0        | 0       | 0       | 0       | 1       | 0       | 1       | 0.4 (%)  |
| OTC, DSM           | 20      | 3        | 1       | 4       | 0       | 28      | 0       | 28      | 10.8 (%) |
| OTC               | 44      | 11       | 4       | 7       | 0       | 3       | 59      | 4       | 66 (25.6)|
| DSM               | 0       | 1        | 0       | 0       | 0       | 1       | 0       | 1       | 0.4 (%)  |

* EM, resistant to erythromycin; OMC, resistant to oleandomycin; OTC, resistant to oxytetracycline; DSM, resistant to dihydrostreptomycin.

** A, arthritis; L, lymphadenitis; E, endocarditis; U, urticaria.

Includes serotypes 3, 5, 6, 8, 11, 21, and N.

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