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COMPARISON OF STREPTOCOCCUS UBERIS AND S. INFREQUENS.
PATHOGENICITY FOR COW UDDER

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Résumé

COMPARAISON DE STREPTOCOCCUS UBERIS ET DE S. INFREQUENS. PATHOGENICITE POUR LA MAMELLE DE LA VACHE. — On a comparé la pathogénicité de Streptococcus uberis et de S. infrequens pour la mamelle de la vache, en inoculant 145 quartiers en période sèche, avec 9 souches de S. uberis (tableau 2) et 11 de S. infrequens, et 58 quartiers en lactation, avec 8 souches de chaque espèce.

On a observé aucune différence entre les deux espèces quant au nombre et à la longueur des infections pendant la lactation suivante (tableau 1). Aucune inoculation en lactation n'a été suivie d'infection.

Les implications pathogéniques et taxonomiques de ces résultats pour la connaissance des relations entre les deux espèces sont discutées.

Introduction

The relationship between Streptococcus uberis (S. uberis) defined by biochemical reactions and the haemolytic streptococci of Lancefield group E is controverted (Obiger and Seeleman, 1961; Roguinsky, 1971). Not all the strains of S. uberis react with E serum, and it is quite impossible to induce anti-E sera in rabbits injected with S. uberis, even with E positive strains (Cullen, 1969).

De Moor and Thal (1968) have defined the species S. infrequens for the haemolytic strains of groups E, P and U, because of their unicity on biochemical grounds. Some strains of S. uberis react also with P and U sera, but their biochemical reactions are similar to the other strains of S. uberis.

The pathogenicity of the two species is different: S. uberis is chiefly involved in cow mastitis, when S. infrequens is found in pig abscesses (Stableforth and Galloway, 1959). There are very few reports of S. uberis in pigs (Kast, 1970; Shuman, Wood and Wessman, 1971) and of S. infrequens in cows (Coffey, 1942).

In this trial their pathogenicity for cow udder was compared by experimental intra-mammary inoculation, mostly during the dry period.
Material and methods

Strains

Nine strains of S. uberis were used as indicated in table 2, including biochemical and serological "variants" (Roguinsky, 1971).

Eleven strains of S. infrequens were used, eight of group E including all serotypes and non typable strains (Payne and Armstrong, 1970) one of each group P and U and one non groupable strain (Shuman and Wessman, 1974).

Inoculations

The protocol of inoculation during the dry period has been described (Roguinsky, 1972).

Thirty cows were inoculated one month after drying-off in their 99 non infected quarters, 45 with S. uberis and 54 with S. infrequens. In case of failure to infect quarters, inoculation was performed one month later with another strain in 46 quarters, 18 with S. uberis and 28 with S. infrequens.

Fifteen cows were inoculated in 58 quarters once during lactation, between the second and the fourth month, with eight strains of S. uberis and eight of S. infrequens, following the same protocol.

The number of germs inoculated during dry period varied from 120 to 20,000, with a mean of 9,000 and a standard error of 300, according to Poisson distribution; for the inoculations during lactation the mean number was 290 (from 20 to 10,000) and standard error 58.

Infections

The cows were sampled: 1) every two weeks during preceding lactation, 2) at drying-off, 3) every week during the dry period, 4) at calving and every two weeks after calving. The milk or secretion was plated on aesculin blood-agar and the streptococci were identified (Plommet, 1962) to know if they were identical to the inoculated strain.

A quarter was defined as being infected at calving if the sample contained the same pathogen as inoculated; if at least two consecutive samples contained the same pathogen, the infection was defined as a persistent infection. Length of infection was defined for a quarter as the number of weeks with persistent infection divided by the number of weeks of the lactation.

Results and discussion

The number and length of experimental infections at calving and during lactation are indicated in table 1. There was no difference between the results of inoculations after the first and after the second month of the dry period, so they were put together on the table. There were no significant differences between infectivity of S. uberis and S. infrequens, neither according to the number of infections at calving and during lactation, nor according to the length of infections. There was also no apparent difference between cows, each being infected during lactation in one quarter by one strain, with the exception of one animal infected in two quarters, one with strain 5-4 of S. uberis and one with a strain of S. infrequens group E.

The inoculations during lactation were not followed by any infection of the inoculated quarters.

The results are not coherent with the pathogenic difference observed in the field between the two species. In this trial S. infrequens produced udder infections similar to those due to S. uberis. On the contrary,

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results of Inoculation During the Dry Period</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Inoculations</th>
<th>Infections at calving</th>
<th>Persistent Infections</th>
<th>Length of Infections **</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. uberis</td>
<td>63</td>
<td>12</td>
<td>7*</td>
<td>0.52</td>
</tr>
<tr>
<td>S. infrequens</td>
<td>82</td>
<td>14</td>
<td>7</td>
<td>0.87</td>
</tr>
</tbody>
</table>

* Plus one clinical mastitis at calving, disappearing spontaneously during the first week of lactation.
** For the definition of the length of infections, see text.
experimental infection with S. uberis does not produce abscesses in pigs (Shuman et al., 1972). But it seems that there is no natural transmission of S. infrequens from pig abscesses to cow udder. It is known that other streptococci, e.g. group L, can be transmitted from pigs to cows (Klastrup, 1963). S. infrequens is perhaps not excreted by the infected pigs, as the abscesses are chiefly localized in neck lymphatic nodes; group L streptococci cause vaginal infections with external discharges. Even if transmission takes place, there is a possibility that S. infrequens does not adhere always to udder cells by the mechanism described by Frost (1975). In that respect, there are notable differences between strains of S. uberis (Frost, personal communication, 1976), some

\[ \text{TABLE 2} \]
\[ \text{Results of Inoculations With The Strains of S. uberis} \]

<table>
<thead>
<tr>
<th>Strain (Origin) *</th>
<th>Characteristics **</th>
<th>Number of Inoculations</th>
<th>Number of persistent infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-16 (Lab)</td>
<td>E +</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>4673 (NCTC)</td>
<td>Normal</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>9927 (ATCC)</td>
<td>CAMP +</td>
<td>8</td>
<td>(Clinical mastitis)</td>
</tr>
<tr>
<td>BE 1 (Beewerth)</td>
<td>CAMP + E +</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>5-4 (Lab)</td>
<td>Normal</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>52-9 (Lab)</td>
<td>CAMP + Starch + E +</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>3858 (NCTC)</td>
<td>E +</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>BG 10 (Beewerth)</td>
<td>CAMP + Raf + G +</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>35-9 (Lab)</td>
<td>CAMP + Raf + Starch + E +</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>

* Origin : Lab, Strains isolated in this laboratory.
** Normal : CAMP, raffinose and starch-negative, ungroupable.
of them adhering very poorly.

In that trial the results of inoculations differ also for the strains of *S. uberis* used (Table 2). There is perhaps significant difference \( (P = 0.08) \) between the "best" and the "worse" strain \( (3/8 \text{ vs } 0/9) \): no relationship can be found between the results and the biochemical or serological characteristics. The strains of *S. infrequens* present less variations; five strains \( (2 \ E \ O, \ 1 \ E \ II, \ 1 \ E \ IV, \ 1 \ U) \) gave one infection for 8 inoculations, the non groupable strain two infections for 9 inoculations, and five strains \( (2 \ E \ I, \ 1 \ E \ III, \ 1 \ E \ V, \ 1 \ P) \) no infection for 8 or 9 inoculations. No differences were observed according the number of germs inoculated.

The failure of all inoculations during lactation seems to be a characteristic of *S. uberis* (Roguinsky, 1972). This can be related to the sensitivity of *S. uberis* to the lactoferrin/thiosulfate/peroxide system, which is active mainly in lactation (Reiter, Sharpe and Higgs, 1970). In this trial, the failure extends to *S. infrequens*, which is probably sensitive to this inhibitory system. This mechanism can be also involved in the elimination of part of the infections present at calving.

From a taxonomic point of view, it is not possible to differentiate the two species by their pathogenicity in bovine udder. But the biochemical differences still remain, *S. uberis* being often positive for amygdalin, arbutin inulin, hippurate and growth at \( 10^\circ \text{C} \), and *S. infrequens* quite always negative (Roguinsky, 1971, and unpublished results). An accurate study of the serological reactions of *S. uberis* with E, P and U sera could result in a better understanding of the relationship between *S. infrequens* and *S. uberis*.

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Summary

The pathogenicity of *Streptococcus uberis* and *S. infrequens* for cow udder was compared by experimental intramammary inoculation, mostly during the dry period. There were no significant differences between the two species according to the number and the length of infections at the subsequent lactation (Table 1). No infections could be established in lactation.

The pathogenic and taxonomic implications of these results are discussed.

References


