OCCURRENCE OF MYCOBACTERIUM AVIUM SUBSP. PARATUBERCULOSIS IN MILK AT DAIRY CATTLE FARMS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction

Presence of Mycobacterium avium subsp. paratuberculosis (MAP) in milk for human consumption is a concern due to its possible relationship with Crohn’s disease in humans. Pasteurization is effective for $10^4$-$10^5$ reduction of the MAP load, but the efficacy depends on the initial MAP concentration, which further depends on the prevalence among contributing herds and individuals (Grant et al., 2005, Rademaker et al., 2007). Considerable variation of MAP in bulk tank milk (BTM) and individual cow’s milk (IM) is reported (Eltholth et al., 2009), but factors associated with MAP occurrence in milk at farm level have not been described. This study systematically reviewed published studies aiming at estimating the occurrence of MAP in on-farm BTM and IM using a meta-analysis.

Materials and methods

The review followed a publicly available guideline (Sargeant et al., 2005) and included five steps; literature search, initial screen, quality assessment, mapping of articles to studies and data extraction, followed by the meta-analysis. The inclusion criteria of the review included: description of the milk samples and the test method, reporting of the numbers of samples and the results. The selected articles were summarized to study level, i.e., the combination of milk samples (BTM or IM), animal species (cow, or other ruminants), test used (culture, IS900 PCR, or F57 PCR) and infection status (infected or unknown). The descriptive analysis summarized all studies, while the following meta-analysis excluded some studies to keep equal weight for each set of samples. Apparent prevalences (AP) in BTM and IM, both overall and for stratum specific, were estimated by the meta-analysis using a random-effects model. The estimated APs and corresponding 95% confidence intervals were shown using forest plots. Furthermore, heterogeneity and dispersion in the reported APs were examined using Cochran’s Q and Higgins’ $I^2$ statistics (Dohoo et al., 2009; Borenstein, 2009).

Results

A total of 692 articles were identified through electronic databases and initially screened based on title and abstract. The quality of the 61 potentially relevant articles was assessed using full text and 31 articles comprising 18 BTM and 27 IM studies were eventually included in the meta-analysis. The AP of MAP in BTM and IM on farm were summarised in relation to strata defined by the test used to identify MAP and the infection status of the herds/animals. Detection limits of the test used and possible MAP load in the test-positive milk samples were rarely reported. The stratum specific AP and 95% confidence intervals of MAP in BTM based on culture of MAP were summarised to 0.06 (0.00-0.77) for known infected herd and 0.01 (0.00-0.08) for unknown infection status herd. Quantifying the MAP load in test-positive milk samples was not possible.

Table. Summary of the meta-analysis of apparent prevalence of MAP in BTM and IM, stratified by diagnostic test and infection status

<table>
<thead>
<tr>
<th>Stratification</th>
<th>Apparent prevalence (95% confidence interval)</th>
<th>BTM</th>
<th>IM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture</td>
<td>0.03 (0.01-0.13)</td>
<td>0.23 (0.07-0.54)</td>
<td></td>
</tr>
<tr>
<td>Known infected</td>
<td>0.06 (0.00-0.77)</td>
<td>0.39 (0.24-0.57)</td>
<td></td>
</tr>
<tr>
<td>Unknown infection status</td>
<td>0.01 (0.00-0.08)</td>
<td>0.20 (0.05-0.56)</td>
<td></td>
</tr>
<tr>
<td>IS900 PCR</td>
<td>0.30 (0.16-0.49)</td>
<td>0.16 (0.11-0.25)</td>
<td></td>
</tr>
<tr>
<td>Known infected</td>
<td>0.68 (0.56-0.78)</td>
<td>0.36 (0.17-0.61)</td>
<td></td>
</tr>
<tr>
<td>Unknown infection status</td>
<td>0.22 (0.15-0.31)</td>
<td>0.14 (0.09-0.21)</td>
<td></td>
</tr>
<tr>
<td>F57 PCR</td>
<td>0.05 (0.03-0.10)</td>
<td>Not available</td>
<td></td>
</tr>
</tbody>
</table>

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Discussions
The different APs in BTM and IM by culture and IS900 PCR could be explained by higher sensitivity of PCR than culture and the ability of PCR being able to detect non-viable MAP. Estimated APs in BTM and IM by the infection status could be used to reduce MAP positivity in milk by using the test history. Meta-analysis and accompanied examination of heterogeneities might be useful to explore the variability in the estimated APs that could be explained by the stratum. There was considerable inconsistency in the reporting, resulting in missing information potentially explaining the dispersion in the estimated AP.

The results of this study can be used in exposure assessments and studies modelling occurrence of MAP in milk at cow and herd level.

A full-length version of this article is scheduled for publication in Veterinary Microbiology. For a full version of the research see ‘Okura, et al. (2012). Occurrence of Mycobacterium avium subsp. paratuberculosis in milk at dairy cattle farms: A systematic review and meta-analysis’. Veterinary Microbiology (DOI: 10.1016/j.vetmic.2011.12.019)

References