Breeding for resistance against Paratuberculosis: Genetic relation between antibody response and faecal shedding of MAP in dairy cattle

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What is Paratuberculosis?

Paratuberculosis is a chronic intestinal infection of ruminants caused by Mycobacterium avium ssp. Paratuberculosis (MAP).

Infections will develop slowly into:
• chronic intractable diarrhea
• weight loss
• production losses
• low birth weight of calves
• ultimately death since no treatment is available
Economical importance

In The Netherlands in 2008:

47% of farms had at least one positive animal
2.4% of all animals was positive

Economical loss:
770,– euro/year per herd (50 animals) with infected cows

For every animal that develops clinical signs
– there will be 7 to 10 animals excreting
– there will be a further 7 to 10 infected, but not yet excreting
   (possibly excreting in the future)
Is breeding against Paratbc possible?

- Goal is reduction of faecal shedding of MAP
- Tool is antibody response in milk

- Are genetic variations of antibody levels and faecal excretion present?
- Is a lower antibody level in milk related to less faecal shedding?
Data

Causative agent of paratuberculosis: Mycobacterium avium ssp. Paratuberculosis (MAP)

Two data sets:
1) Individual milk samples tested by Elisa for antibodies against MAP (trait=PA1)

2) Individual faecal samples tested for MAP bacteria (trait=PA2)
Method

• Estimation of genetic parameters for PA1 and PA2

• Estimation of genetic correlation between breeding values for PA1 and PA2
Results: genetic effects

<table>
<thead>
<tr>
<th></th>
<th>PA1</th>
<th>PA2</th>
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<tbody>
<tr>
<td>$\sigma^2_g$</td>
<td>0.004</td>
<td>0.005</td>
</tr>
<tr>
<td>$\sigma^2_{perm}$</td>
<td>0.033</td>
<td>0.021</td>
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<tr>
<td>$\sigma^2_p$</td>
<td>0.081</td>
<td>0.081</td>
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<tr>
<td>repeatability</td>
<td>0.42 (0.003)</td>
<td>0.28 (0.006)</td>
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<tr>
<td>$h^2$</td>
<td>0.05 (0.003)</td>
<td>0.06 (0.008)</td>
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Heritability and genetic variation indicate possibilities for selection.
Genetic correlation

• Genetic correlation between breeding values estimated with milk (PA1) and faecal (PA2) analyses
• Genetic correlation was estimated, accounting for differences in repeatability of breeding values (MACE)
• Sires have at least 15 daughters

• Genetic correlation PA1-PA2: 0.81
Implications

• Genetic standard deviation for ELISA test (antibody levels): 0.063
• *Increase* in breeding value means *decrease* in antibody levels
• Using a bull with 1 genetic standard deviation higher breeding value: 2.8% less daughters tested positive