Relationships between immune traits found in the blood and milk of Holstein-Friesian dairy cows

SJ Denholm, TN McNeilly, G Banos, MP Coffey, GC Russell, A Bagnall, MC Mitchell and E Wall

66th Annual Meeting – August 31st to September 4th Warsaw, Poland
Introduction

- Health and welfare of animals is an important issue
- Maintaining healthy herd requires early indication of issues
Introduction

- **Financial losses** from disease, culling and infertility within the herd
- Monitor and manage losses
- **Immune traits**!
Introduction

Immune traits

measurable in blood!
Introduction

Immune traits

measurable in blood!

1 Banos et al. (2013)
Introduction

Immune traits

measurable in blood!

health\(^1\)
fertility\(^1\)

\(^1\) Banos et al. (2013)
Introduction

Immune traits

- health

- fertility

measurable in blood!

- production

1 Banos et al. (2013)
Introduction

- Milk is **routinely** collected
- **Less invasive** resource
- Easily measurable
Aim

Relationships between immune traits in blood and milk?
Materials and Methods

- **288 Holstein-Friesian dairy cows**
- Housed at the SRUC Dairy Research Centre
Materials and Methods

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- **Housed at the SRUC Dairy Research Centre**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Select</th>
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</thead>
<tbody>
<tr>
<td>Homegrown</td>
<td>64</td>
<td>76</td>
</tr>
<tr>
<td>Byproducts</td>
<td>77</td>
<td>71</td>
</tr>
</tbody>
</table>
Materials and Methods

- **288 Holstein-Friesian dairy cows**

- Housed at the SRUC Dairy Research Centre

- 11 milk and serum sampling points

- Apr 2013 – Jul 2014
Materials and Methods

- 288 Holstein-Friesian dairy cows
- Housed at the SRUC Dairy Research Centre
- Milk and serum samples assayed by ELISA
- 11 milk and serum sampling points
- Apr 2013 – Jul 2014
Materials and Methods

- 288 Holstein-Friesian dairy cows
- Housed at the SRUC Dairy Research Centre
- Milk and serum samples assayed by ELISA
- 11 milk and serum sampling points
- Apr 2013 – Jul 2014
- Natural antibodies (NAb)
- Haptoglobin (Hp)
- Tumor necrosis factor (TNF-α)
The Dataset

- 474 cows
- 8 immune traits
- 2,771 cows in pedigree
- 6 generations
- 4,712 records
- 2010 – 2014
- 4 year sampling period
Statistical analyses

• Data were analysed using a mixed linear animal model

\[ y_{ijklmnop} = \mu + F_i + G_j + W_k + A_l + H_m + C_n + S_o + a_p + p_p + e_{ijklmnop} \]

(Gilmour et al., 2009)
Statistical analyses

\[ y_{ijklmnop} = \mu + F_i + G_j + W_k + A_l + H_m + C_n + S_o + a_p + p_p + e_{ijklmnop} \]

- Diet group
- Genetic group
- Lactation week
- Lactation number
- Age at calving
- Assay technique
- Cow health status
- Year of calving
- Month of calving
- Overall mean
Statistical analyses

\[ y_{ijkmnop} = \mu + F_i + G_j + W_k + A_l + H_m + C_n + S_o + a_p + p_p + e_{ijkmnop} \]

- Overall mean
- Genetic group
- Assay technique
- Lactation week
- Lactation number
- Age at calving
- Year of calving
- Month of calving
- Cow health status
- Cow
- Error
- Permanent environmental effect
Genetic parameters

Heritability

- **serum**
- **milk**

- **Hp**
- **NAb kHN**
- **NAb LPS**
- **TNFa**
Genetic parameters

Repeatability

- Serum
- Milk

<table>
<thead>
<tr>
<th>Protein</th>
<th>Serum Repeatability</th>
<th>Milk Repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hp</td>
<td>0.00</td>
<td>0.40</td>
</tr>
<tr>
<td>NAb Kth</td>
<td>0.45</td>
<td>0.75</td>
</tr>
<tr>
<td>NAb LPS</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>TNFa</td>
<td>0.40</td>
<td>0.50</td>
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</table>
Blood vs. milk NAb

- NAb KLH (blood) vs. NAb LPS (blood)
  - Phenotypic Correlation: 0.42
  - Genetic Correlation: 0.99

- NAb KLH (blood) vs. NAb KLH (milk)
  - Phenotypic Correlation: 0.64
  - Genetic Correlation: 0.77

- NAb KLH (milk) vs. NAb LPS (milk)
  - Phenotypic Correlation: 0.31
  - Genetic Correlation: 0.61

- NAb LPS (blood) vs. NAb LPS (milk)
  - Phenotypic Correlation: 0.72
  - Genetic Correlation: 0.88

- NAb LPS (milk) vs. NAb KLH (blood)
  - Phenotypic Correlation: 0.54
  - Genetic Correlation: 0.85
<table>
<thead>
<tr>
<th>Immune vs. milk</th>
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<tbody>
<tr>
<td><strong>Milk (kg)</strong></td>
</tr>
<tr>
<td><strong>NAb KLH</strong></td>
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<tr>
<td><strong>NAb LPS</strong></td>
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<table>
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<tr>
<th><strong>Correlation Values</strong></th>
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<tr>
<td>Milk (kg)</td>
</tr>
<tr>
<td>-0.20 -0.57</td>
</tr>
<tr>
<td>-0.21 -0.58</td>
</tr>
<tr>
<td>-0.01 -0.45</td>
</tr>
<tr>
<td>-0.16 -0.53</td>
</tr>
<tr>
<td>NAb KLH</td>
</tr>
<tr>
<td>0.55 0.95</td>
</tr>
<tr>
<td>-0.02 -0.48</td>
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<tr>
<td>0.11 0.10</td>
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<td>-0.01 -0.37</td>
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<tr>
<td>0.09 0.38</td>
</tr>
<tr>
<td>TNF-α</td>
</tr>
<tr>
<td>0.07 0.27</td>
</tr>
<tr>
<td>Hp</td>
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*Phenotypic Correlation*  *Genetic Correlation*
Immune vs. milk
Immune vs. SCC

- SCC (x10^3 /ml)
- NAb KLH (milk)
- NAb LPS (milk)
- TNF-α (milk)
- Hp (milk)

Phenotypic Correlation | Genetic Correlation
--- | ---
0.17 0.10 | 0.15 0.32 | 0.10 0.46 | 0.43 0.88
0.55 0.95 | -0.02 -0.48 | 0.11 0.10
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0.07 0.27
Immune vs. SCC

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Conclusions

• Immune traits in blood and milk are heritable, repeatable and strongly correlated

• Highlights potential as a less invasive resource for predictive modelling of animal immune traits
Next Steps . . .

- Associations with health and welfare
- Immune time series
Acknowledgements

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Acknowledgements

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Thanks for listening

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