Pig peripheral blood mononuclear leucocyte (PBML) sub-sets are heritable, and genetically correlated with performance.

Mary Clapperton, Stephen Bishop,

Elizabeth Glass.

Roslin Institute (Edinburgh), Roslin, Midlothian UK

- ***Infection:***

  - reduces productivity
  - control measures, only partially effective
  - animal welfare

- ***Contribution:***

  - select animals with increased resistance towards infectious disease

How to measure increased resistance to infectious disease?

- *Problem:*

  - can't detect all pathogens

  - sub-clinical infections - no symptoms

- *Solution:*

  - measures of the immune response, i.e. immune traits

Selection criteria for immune traits, as markers for resistance towards infectious disease.

- Heritable
- Correlate with parameters of disease resistance *eg*. performance, health etc.
- Easy to measure; reproducible.
- No challenge of animal required.

The immune response, and immune traits

Use markers that are easy to measure

⟶ peripheral blood leucocytes?

The immune response, and immune traits

polymorphonuclear leucocytes

peripheral blood leucocytes

mononuclear leucocytes

Pig peripheral blood mononuclear leucocyte sub-sets

- CD4
- CD8
- B cells
- gamma delta ($\gamma\delta^+$) T cells
- monocytes
- NK cells

Pig peripheral blood mononuclear leucocyte sub-sets

- CD4 - ‘helper’; cytokine release
- CD8 - destroy infected cells
- B cells
- gamma delta (γδ+) T cells
- monocytes
- NK cells

Pig peripheral blood mononuclear leucocyte sub-sets

- CD4 - ‘helper’; cytokine release
- CD8 - destroy infected cells
- B cells - produce antibody
- gamma delta ($\gamma\delta^{+}$) T cells - immune surveillance?
- monocytes
- NK cells

Pig peripheral blood mononuclear leucocyte sub-sets

- CD4 - 'helper'; cytokine release
- CD8 - destroy infected cells
- B cells - produce antibody
- gamma delta ($\gamma\delta^+$) T cells - immune surveillance?
- monocytes - destroy pathogens; release cytokines
- NK cells - destroy infected cells
  - $CD11R1^+$ although no specific marker for NK cells exists

Pig PBML subsets - past work
(Clapperton *et al*., 2005)

- 128 apparently healthy pigs
- Farm - intermediate health status
- Correlate performance against % PBML subsets.
- *Decreasing* performance correlate against *increasing* 'NK cells', B cells, monocytes.

Pig PBML subsets - past work
(Clapperton *et al*., 2006)

- Same farm as for previous study.
- Pig lines - lean growth under restricted feeding
  - 2 lines: 38 high line pigs v. 31 low line pigs
- High line > low line: WBC, CD8α$^+$, 'NK cells'

Pig PBML subsets - past work
(Clapperton *et al*., 2005, 2006)

Overall:

- **Negative correlation with performance:**
  'NK cells', B cells, monocytes

- **High v. low lean growth pig lines - line differences:**
  total WBC, CD8α$^+$ cells, 'NK cells'

- ⟶ **PBML subsets - heritable?**
  - correlate with performance?

Present study:

- Are PBML subsets heritable?
- Do PBML subsets genetically correlate with performance?

Are PBML subsets heritable?

- ca. 500 pigs
- ca. 120 sires
- farm health status: 3 high, 2 low
- % PBML subsets, at start- and end-test

  total WBC, $CD4^+$ T cells,

  $CD8\alpha^+$ cells, $\gamma\delta^+$ T cells,

  B cells, monocytes, 'NK cells'
- Test - ca. 30kg; end-test = 90kg.

Are PBML subsets heritable?

Immune traits	*heritability ($h^2 \pm se$)*
white blood cells	0.25±0.11
$CD4^+$ T cells	0.62±0.14
$CD8\alpha^+$ cells	0.18±0.13
$\gamma\delta^+$ T cells	0.52±0.14
'NK cells'	0.58±0.14
B cells	0.59±0.14
monocytes	0.59±0.14

All immune traits were moderately to highly heritable, except for $CD8\alpha^+$ cells.

Heritabilities were similar at both timepoints (start and end-test).

Is heritability influenced by farm health status?

- Some variability in individual heritabilities for high v. low health status farms.

- mean h^2 in both cases = 0.48

  ⟶ no overall trend caused by health status

Are PBML subsets genetically correlated with performance?

- Genetic correlation = correlation of underlying genotypes
- Methods:

  6 farms
  farm health status: 3 high, 3 low
  495 pigs - PBML subsets
  - same pigs as for heritability measures
  - start- and end-test
  1568 pigs - performance

- Performance - daily weight gain from ~ 30kg to ~ 90kg

Are PBML subsets genetically correlated with performance?

End-test measurements:

Immune trait	*correlation (r)*
'NK cells'	- 0.72±0.17*
B cells	- 0.30±0.19
monocytes	- 0.30±0.19

* $p < 0.01$

Conclusions

- Most major PBML subsets, except CD8α^{+} cells, were heritable.

- Significant genetic correlation between ‘NK cells’ and performance.

Conclusions

- Selecting boars with lower levels of certain immune traits, especially ‘NK cells’, could lead to higher performing progeny.

Acknowledgements

Pigs - Pig Consortium (JSR Genetics, Genus, Rattlerow Farms)

Funding - DEFRA LINK
- Pig Consortium
- BBSRC