Invited Review: Piglet Survival – Benefits of the immunocompetence

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Short title: Piglet Survival – Benefits of the immunocompetence

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**Supplementary Material**

Table S1 Genomic analyses for haemopoetic traits in pigs

| Method | Traits | Breed | Reference |
| --- | --- | --- | --- |
| Transcriptome analysis | total white blood cells, lymphocyte counts, proportions of various leucocyte subsets, cells harbouring IgM, γδTCR, CD4/CD8, CD16/CD2 and CD16/CD172a/MHCII, phagocytosis & in vitro production of IL1B, IL6, IL8, TNF, IL12 and IFNα after blood stimulation, lymphocyte proliferation, in vitro production of IL2, IL4, IL10 and IFNγ after blood stimulation, total IgG, IgA, IgM, specific IgG levels, C-reactive protein, haploglobin | French Large White | Flori *et al.* (2011b) |
| GWAS & LONG-GWAS | Hematocrit, hemoglobin, HBE, MCHC, MCV, erythrocytes, RDW, granulocytes (%), amount of granulocytes, monocytes (%), amount of monocytes, lymphocytes (%), amount of lymphocytes, leucocytes, thrombocytes, PCT, PDW, MPV | White Duroc ×  Erhulian F2 | Zhang *et al.* (2013) |
| GWAS of DNA pools | γ-Immunokrit | Landrace x (Duroc x Yorkshire) | Rohrer *et al.* (2014) |
| GWAS &  haplotype analysis | Hematocrit, hemoglobin, HBE, MCHC, MCV, erythrocytes, RDW-SD, lymphocytes (%), amount of lymphocytes, leucocytes, thrombocytes, PDW, MPV, P-LCR | Chinese Sutai | Zhang *et al.* (2014a) |
| GWAS &  multi-marker analysis | Leucocytes, lymphocytes, erythrocytes, hemoglobin, hematocrit, MCV, HBE, MCHC, thrombocytes, RDW, MPV, PCT | German Landrace | Ponsuksili *et al.* (2016) |
| GWAS & LDA & PCA | Leucocytes, neutrophils, neutrophils (%), lymphocytes, lymphocytes (%), monocytes, monocytes (%), erythrocytes, MCV, hemoglobin, hematocrit, HBE, MCHC, RDW, thrombocytes, MPV, PDW, PCT | Landrace,  Large White,  Songliao Black | Wang *et al.* (2013) |
| GWAS | Hematocrit, hemoglobin, HBE, MCHC, MCV, erythrocytes, RDW | Large White ×  Minzhu F2 | Luo *et al.* (2012) |
|  |  |  |  |
| GWAS & LDA | IFNγ, IL 10, IFNγ-IL10-ratio, IgG | Landrace, Yorkshire, Songliao Black | Lu *et al.* (2013) |
| Linkage analysis/QTL mapping with microsatelites | T lymphocyte subpopulations: proportions of CD4+, CD8+, CD4+CD8+, CD4+CD8-, CD4-CD8+, and CD4-CD8- T cells and the ratio of CD4+:CD8+ T cells | Landrace, Large White, Songalio Black pig | Lu *et al.* (2011) |

GWAS=Genome-wide association studies, QTL=Quantitative trait loci, LONG-GWAS=longitudinal GWAS, LDA=Linkage disequilibrium analysis, PCA=Principle component analysis, HBE=Hemoglobin concentration in blood, MCHC=Mean corpuscular hemoglobin concentration, MCV=Mean corpuscular volume, RDW=Red cell distribution width, RDW-SD= Red cell distribution width – standard deviation, PCT=Volume occupied by platelets, PDW=Platelet distribution width, MPV=Mean platelet volume, P-LCR=Platelet large cell ratio, IFN=Interferone, IL=Interleukin, IgG=Immunoglobulin G, TNF=Tumor necrosis factor.

Table S2 Genome-wide association studies (GWAS), candidate gene and linkage analyses for traits associated with piglet survival

| Method | Traits | Breed | Reference |
| --- | --- | --- | --- |
| Candidate gene analysis | TNB, NBA | Meishan | Rothschild *et al.* (1996) |
| QTL mapping via microsatellites | TNB, NSB, NBA | Large White, Yorkshire | Tribout *et al.* (2008) |
| Candidate gene analysis | TNB, NSB, PM | American Large White, Landrace | Sironen *et al.* (2010) |
| GWAS (BM) | TNB, NBD, NSB, MUM, LBW, ABW | Crossbreds | Schneider *et al.* (2012) |
| Whole-genome association study | TNB, NSB, PM | Finnish Landrace | Uimari *et al.* (2011) |
| Whole-genome association study | TNB, NBA, NSB, MUM | Large White x Landrace | Onteru *et al.* (2012) |
| Genome-wide linkage analysis | TNB, NBA, PS | Large White x Meishan F2 | Hernandez *et al.* (2014) |
| GWAS | HEBV and LEBV for IBW | Crossbreds | Zhang *et al.* (2014b) |
| GWAS | NSBIL, NSBL, PCSPIL | Crossbreds | Schneider *et al.*, 2015 |
| GWAS | NBA | Landrace, Large White | Bergfelder-Drueing *et al.* (2015) |
| GWAS | TNB, varTNB | Large White | Sell-Kubiak *et al.* (2015) |
| GWAS (BM) | TNB, LS 5, MORT | Danish Landrace | Guo *et al.* (2016) |
| GWAS (BM) & generation of gene-transcription factor networks | NSB, NT | Large White | Verardo *et al.* (2016) |
| Candidate SNP analysis | TNB, NBA, ABW, PM | Large White | Sato *et al.* (2016) |
| GWAS | PU | Large White | Wang *et al.* (2017) |
| GWAS | NBT, NBA | Erhualian | Ma *et al.* (2018) |
| GWAS | NBT, NBA, LBW, ABW | Large White | Wang *et al.* (2018) |
| Candidate gene analysis | NBT, NPD, NSB, NBDA, ABW | Yorkshire | Jonas and Rydhmer (2018) |

GWAS=Genome-wide association studies, SNP=Single nucleotide polymorphism, QTL=Quantitative trait loci, BM=Bayesian models, TNB=Total number of piglets born, NSB=Number of stillborn piglets, NBA=Number of piglets born alive, NBD=Number of piglets born dead, MUM=Number of mummies, LBW=Total litter birth weight, ABW=Average birth weight, PM=Piglet mortality between birth and weaning, PS=Prenatal survival, HEBV=High estimated breeding values for the individual birth weight, LEBV=Low estimated breeding values for the individual birth weight, IBW=Individual birth weight, NSBIL=Number of stillborn piglets ignoring the last piglet born per litter, NSBL=Number of stillbotn in the last birth position, PCSBIL=Percent stillborn ignoring the last piglet, LS 5=Litter size at day 5, MORT=Mortality rate before day 5, PU=Piglet uniformity, NPD=Dead piglets of total born, NBDA=Dead piglets of live born, varTNB=Variability of TNB, NT=Number of teats, NBT=Number of piglets born total.

Table S3 Heritabilities (h² ± SEM) in blood parameters of the porcine immune system (Full table)

| Parameters | Edfors-Lilja *et al.* (1994) | Henryon *et al.* (2006) | Clapperton *et al.* (2008) | Clapperton *et al.* (2009) | Flori *et al.* (2011a) | Mpetile *et al.* (2015) | Ponsuksili *et al.* (2016) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| n | 220 | 4204 | 500 | 606 | 443 | 518 | 591 |
| Breed | Swedish Yorkshire | Duroc, Landrace, Yorkshire | Large White | Large White, Landrace | Large White | Yorkshire | Landrace |
| Leukocytes | 0.44 (0.29) | 0.25 (0.05) | 0.24 (0.15) | 0.28 (0.11) | 0.73 (0.20) | 0.23 (0.19) | 0.23 |
| Neutrophiles |  | 0.22 (0.04) |  |  | 0.61 (0.20) | 0.31 (0.21) |  |
| Lymphocytes | 0.24 (0.21) | 0.24 (0.05) |  |  | 0.72 (0.21) | 0.15 (0.19) | 0.49 |
| Monocytes |  | 0.22 (0.04) | 0.52 (0.17) | 0.26 (0.13) | 0.38 (0.20) | 0.36 (0.20) |  |
| Eosinophils |  | 0.30 (0.05) |  |  | 0.80 (0.21) | 0.58 (0.12) |  |
| Basophils |  |  |  |  |  | 0.12 (0.19) |  |
| Thrombocytes |  |  |  |  | 0.56 (0.19) | 0.11 (0.23) | 0.39 |
| Erythrocytes |  |  |  |  | 0.43 (0.20) | 0.62 (0.25) | 0.41 |
| Haemoglobin |  |  |  |  |  | 0.56 (0.13) | 0.40 |
| Hematocrit |  |  |  |  | 0.57 (0.03) | 0.06 (0.14) | 0.34 |
| MCV |  |  |  |  |  | 0.47 (0.24) | 0.69 |
| HBE |  |  |  |  |  | 0.37 (0.24) | 0.67 |
| MCHC |  |  |  |  |  | 0.04 (0.16) | 0.67 |
| IFNγ |  |  |  |  | 0.00 (0.17) |  |  |
| IL10 |  |  |  |  | 0.35 (0.19) |  |  |
| IL12 |  |  |  |  | 0.51 (0.20) |  |  |
| IL1beta |  |  |  |  | 0.12 (0.19) |  |  |
| IL4 |  |  |  |  | 0.15 (0.18) |  |  |
| IL6 |  |  |  |  | 0.11 (0.19) |  |  |
| IL8 |  |  |  |  | 0.00 (0.17) |  |  |
| TNFalpha |  |  |  |  | 0.00 (0.19) |  |  |
| Haptoglobin |  | 0.14 (0.07) |  | 0.20 (0.11) | 0.55 (0.21) |  |  |

MCV=Mean corpuscular volume, HBE=Hemoglobin concentration in blood, MCHC=Mean corpuscular hemoglobin concentration, IFN=Interferone, IL=Interleukin, TNF=Tumor necrosis factor

**Table S4:** *Heritabilities* (h² ± SEM) *for survival traits in pigs (dam lines and crossbreds)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | ht2 | hd2 | hm2 | Breed |
| Number of piglets born alive | 0.12 (0.04)2  0.08 (0.02)4  0.10 (0.03)5 | 0.11 (0.02)8 |  | Yorkshire2,  Large White4,  Landrace5 8 |
| Number of stillborn piglets | 0.05 (0.03)1  0.19 (0.02)4  0.05 (0.03)5 |  |  | 3 dam lines1  Large White4  Landrace5 |
| Proportion of stillborn piglets  Stillbirth | 0.13 (0.04)2 | 0.043a | 0.103a | Yorkshire2  Large White3 |
| Individual survival at birth  Total pre-weaning mortality  Pre-weaning survival | 0.042 (0.009)6  0.01-0.0410 | 0.035 (0.006)6  0.00-0.0210  0.219  0.033b  0.249 | 0.057 (0.009)6  0.04-0.1210  0.159  0.093b  0.149 | Landrace6  Dam lines10  Crossbreds9  Large White3  Crossbreds9 |
|  |  |  |  |  |
| Survivability to day 5 | 0.093 (0.012)6 | 0.056 (0.010)6 | 0.04 (0.008)6 | Landrace6 |
| Survivability from day 6 to weaning | 0.015 (0.007)6 | 0.027 (0.011)6 | 0.03 (0.011)6 | Landrace6 |
| Individual birth weight | 0.147 (0.016)6 | 0.090 (0.012)6  0.043b  0.369 | 0.160 (0.016)6  0.153b  0.289 | Landrace6  Large White3b  Crossbreds9 |
| Mean birth weigth | 0.31 (0.05)1  0.39 (0.05)2 | 0.32 (0.06)8 |  | 3 dam lines1  Yorkshire2 |
| Mean body weight at 3 weaks of age | 0.19 (0.04)2 | 0.17 (0.02)8 |  | Yorkshire2  Landrace8 |
| Piglet mortality |  | 0.02 (0.02)7  0.06 (0.01)7 | 0.05 (0.01)7  0.13 (0.02)7 | Large White7  Landrace7 |

ht2=total heritability;hd2=direct heritability;hm2=maternal heritability; 1Hermesch *et al.* (2001); 2Damgaard *et al.* (2003); 3Arango *et al.* (2006) (3aModel 3, 3bModel 1); 4Canario *et al.* (2006); 5Hellbrügge et al. (2008); 6Su *et al.* (2008); 7Ibanez-Escriche *et al.* (2009); 8Canario *et al.* (2010); 9Roehe *et al.* (2010); 10Kapell *et al.* (2011)

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