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Aetiology and consequences of reproductive tract diseases in dairy cows

A thesis presented in partial fulfilment of the requirements for the degree of
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Abstract

Reproductive tract diseases of dairy cows are common world-wide and results in a decrease in reproductive performance. The research presented in this thesis evaluates the available diagnostic methods for reproductive tract diseases, including the quality of published reports describing these methods in dairy cows. To improve the accuracy of cow-side diagnostic tests for reproductive tract diseases more research is needed, specifically to establish optimal cut-points, timing of examination and test variability (i.e. intra- and interobserver agreement). Moreover, future manuscripts reporting on diagnostic methods for reproductive tract diseases could be improved by using checklists for quality of design and reporting as a guideline.

Research was also done to assess the presence of intrauterine bacteria in early postpartum New Zealand dairy cows and their association with the subsequent reproductive tract infection, inflammation and reproductive performance. The isolation of intrauterine bacteria, irrespective of type, at 23 days postpartum was associated with a decrease in pregnancy within three weeks for the start of the seasonal breeding programme (planned start of mating; PSM; P = 0.05). *Escherichia coli* isolated at 23 days postpartum tended to increase the time to pregnancy (P = 0.09). However, the presence of *E. coli* within the first week postpartum was not significantly associated with isolation of *Trueperella pyogenes* three weeks later (P = 0.53). An interesting finding was the positive association between the elevated recruitment of polymorphonuclear cells in the early postpartum period and a decreased time to pregnancy (P = 0.05).

Susceptibility data, based on minimum inhibitory concentration (MIC), was generated for a range of antimicrobials against *E. coli* and *T. pyogenes* from intrauterine origin. Between-herd and between age-
group differences in MIC were detected ($P \leq 0.05$). Cows diagnosed with intrauterine *E. coli* with an MIC of $\geq 8 \, \mu g/mL$ at 23 days postpartum tended to be at lower risk of pregnancy within six weeks of PSM relative to an MIC of $<8 \, \mu g/mL$ ($P = 0.09$). No interpretative criteria are available for MIC data of antimicrobials against uterine isolates. Hence, more research is required on pharmacokinetic and pharmacodynamic profiles for veterinary antimicrobials.

This thesis describes the first isolation of apparent antibodies to bovine herpesvirus type 4 and the DNA of bovine lymphotropic herpesvirus in New Zealand dairy cattle, both of which may play an important role in the pathogenesis of reproductive tract diseases. Further studies are required to investigate the true impact of these viruses.

The research presented in this thesis provided data useful for further improvement of diagnosis and treatment of reproductive tract diseases in dairy cows.
Acknowledgements

As I’m sitting here surrounded by piles of paper collected over the last number of years, notes, draft versions of manuscripts, and multiple printouts of peer-reviewed manuscripts I’m reflecting on the last few years that have been entirely dedicated towards the creation of this thesis. Returning to New Zealand to start this PhD project was life-changing in many ways. I am pleased to have this opportunity to thank a large number of people. Without them this demanding journey would have been an ordeal.

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Abbreviations

Al   Artificial insemination
BCS  Body condition score
BHBA β-hydroxybutyric acid
BHI  Brain heart infusion
BLAST Basic local alignment search tool
BLHV Bovine lymphotropic herpesvirus
BoHV-4 Bovine herpesvirus type 4
bp   Base pair
BUN  Blood urea nitrogen
CCFA Ceftiofur crystalline free acid
CFU  Colony forming unit
CL   Corpus luteum
CLSI Clinical and Laboratory Standards Institute
DIM  Days in milk
ELISA Enzyme-linked immunosorbent assay
EnPEC Endometrial pathogenic Escherichia coli
EUCAST European Committee on Antimicrobial Susceptibility Testing
MAC  Macrophages
MIC Minimum inhibitory concentration
MIC_{50} The antimicrobial concentration that inhibits 50% of the bacterial isolates
MIC_{90} The antimicrobial concentration that inhibits 90% of the bacterial isolates
NEFA  Non-esterified fatty acid
OD    Optical densities
ONPG  An enzymatic test for Ortho-nitrophenyl-β-galactosidase
OUMI  ONPG, urase, motility, indol agar tests
PBMC  Peripheral blood mononuclear cells
PGE₂  Prostaglandin E₂
PGF₂α  Prostaglandin F₂α
PMN   Polymorphonuclear cells
PSM   Planned start of mating (the seasonal start of the breeding season)
PVD   Purulent vaginal discharge
RFM   Retained foetal membranes
ROC   Receiver-operating characteristic analysis
Se    Sensitivity (the proportion of diseased animals that test positive)
Sp    Specificity (the proportion of non-diseased animals that test negative)
TAGS  Tests in absence of a gold standard
TSI   Triple sugar iron agar test
VDS   Vaginal discharge score
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