Prediction of bull fertility

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Summary

- Current semen assessments can identify infertile bulls, but are not sufficient for identifying sub-fertile bulls.
- Detailed laboratory assessments may aid identification of sub-fertile ejaculates.
- Semen assessments will need to be tailored to the semen processing method (i.e., sexed or conventional).

Introduction

It is necessary to achieve excellent reproductive performance with artificial insemination (AI) events to achieve a compact calving pattern. Therefore quality control of semen used for AI is critically important. Typical quality control measures carried at AI stations include ejaculate volume, sperm concentration, pre- and post-thaw sperm motility and sperm morphology. These tests are generally sufficient for identifying ejaculates with very poor semen quality (which are discarded), but are poor at distinguishing between ejaculates of average and high fertility, thus resulting in variable conception rates.

Factors affecting sperm quality

Semen production and sperm quality can be affected by age and breed of the bull, and also by external factors, such as elevated temperature due to excessive fat or fever, trauma to the testicular tissue, diet and exposure to toxins. These issues likely become more critical when semen is also sex-sorted. Even though quality control standards are higher for sex-sorted semen (before and after processing), there is inevitable sperm damage, and the low number of sperm per AI straw leaves little room to compensate for low fertility.

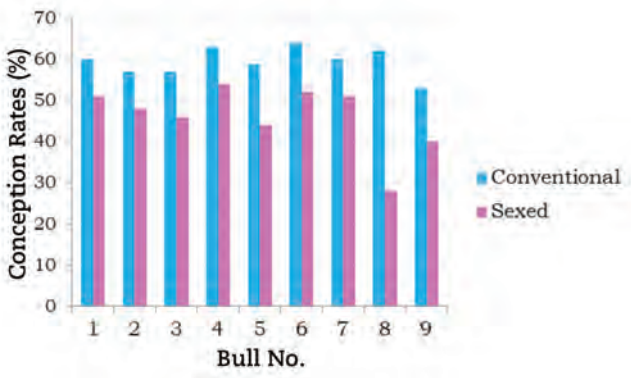


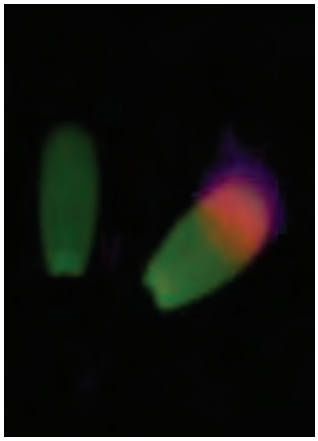
Figure 1. *Variation in conception rates by bull for conventional and sexed semen (2018 field trial)*

Large sexed semen field trials were conducted in 2013 and 2018. Large variation between and within individual bulls was noted in conception rates achieved for both conventional and sex-sorted semen (Figure 1).

Fertility prediction

Many studies have tried to relate laboratory sperm assessments to conception rates in bulls. The most common assessments include motility, viability and DNA fragmentation, but accuracy of fertility prediction has been variable. Moorepark research aims to develop a predictive model using detailed sperm assessments to predict fertility. As sperm fertility relies on a number of different factors, assessments will focus on specific physiological characteristics of the sperm to provide an overall picture of the fertility potential of a particular ejaculate. One such assessment is acrosome integrity; a sperm cell with a ruptured acrosome is unable to fertilise an oocyte (Figure 2a). Other assessments such as mitochondrial function and membrane fluidity are related to the ability to maintain motility inside the female reproductive tract. Conventional sperm have lower viability and more sperm with intact acrosomes and a lower population with high membrane fluidity compared with sex-sorted semen (Figure 2b). More research is required using both conventional and sex-sorted semen straws to develop a suite of tests that can predict bull fertility.

2a



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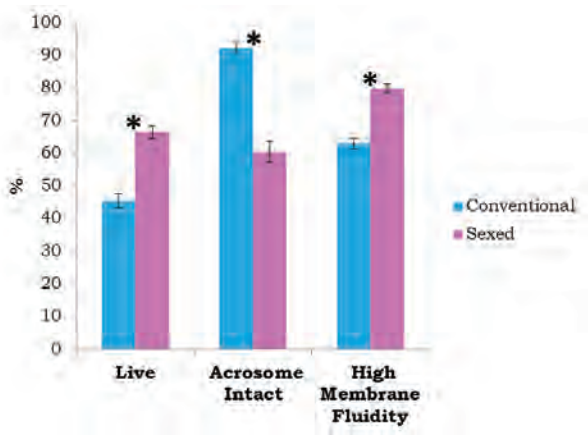

Figure 2. *(2a) Sperm cells being analysed for acrosome integrity. The purple/red halo on the sperm head indicates a ruptured acrosome membrane, resulting in inability to fertilise (100x magnification). (2b) Assessments of sperm physiology for both conventional and sex sorted-semen*

Conclusions

Detailed measures of sperm physiology — in particular viability, acrosome integrity and membrane fluidity — vary between conventional and sex-sorted sperm populations. These differences may be used to identify markers of subfertility, and thus predict the fertility of a particular ejaculate before being used in the field. Further analysis using more assessments is required to develop a model to accurately predict fertility.