The Future of Artificial Insemination?

Murray Pettitt
Assistant Manager – External Research Services
Prairie Swine Centre Inc.
Saskatoon, SK

Executive Summary

During the last decade, an increasingly important technology in optimizing the production system has been the widespread adoption of artificial insemination (AI). The benefits of AI include decreased production costs, increased rate of genetic improvement, reduced disease transfer, and a more uniform and improved product at the packing plant. With appropriate timing and management, fertility can match or exceed levels achieved with natural mating. Due to its technical nature however, care must be taken to ensure all steps are performed correctly in order to achieve the highest fertility rates. New research aimed at lowering the cost of AI may actually eliminate some of these technical issues so that AI becomes more efficient and easier to use than ever. This paper will review a few of these issues and the new research surrounding them.

Liquid Semen Extenders

The functions of an extender are to dilute the sperm cells in the ejaculate and to preserve sperm viability during storage at reduced temperatures. Common extender components include glucose for an energy source, buffers to control pH, inorganic ions to control osmotic pressure, membrane stabilizers and antibiotics to control bacterial growth.

Boar semen extenders are typically divided into short term (≤ 3 days) or long term (≥ 4 to 7 days) categories. These classifications are based on how long boar semen can be stored in the extender without a significant drop in fertility. Long-term extenders typically have a much more complex chemical formula and higher cost than do the short-term extenders. Choice of extender is based on cost and the length of the required shipping and storage periods. Extended semen must not be used beyond the storage time that the extender can preserve adequate fertility or a reduction in herd fertility will occur.

Many operations purchase semen from commercial studs. Large geographical distances between the studs and production units make shipping time lengthy and costly. The longer shipping times can expose the shipment to greater temperature challenges that could affect the quality of the extended semen. Development of true long-term extenders that would provide commercially acceptable farrowing rates and litter sizes beyond 6 to 8 days of semen storage would greatly benefit the industry. These true long-term extenders would allow fewer shipments per week, decreased shipping costs per dose, improved semen supply - estrus timing and longer storage with adequate fertility. It would also increase collection efficiency, both on-farm and at commercial studs.

Recently, two long-term extenders were compared in a large-scale fertility trial (Kuster and Althouse, 1999). Semen was collected, pooled into groups of four boars, and extended in either Androhep® or X-Cell™ extender. Extended semen was stored at 15 to 17°C for 2 to 3 d, 3 to 4...
d, 4 to 5 d, or 5 to 6 d before inseminating first-service gilts. Farrowing rates ranging from 85.1 to 86.6 % were similar between extenders at all semen storage times except for the semen stored in Androhep® for 5 to 6 d. The farrowing rate for this semen was significantly lower at 78.6 %. Similarly, total born alive did not change with age of semen extended in X-Cell™ and ranged from 8.9 to 9.8. Total born alive decreased from 9.5 to 8.4 in both the 3 to 4 d and 4 to 5 d Androhep® groups and then rebounded to 8.8 in the 5 to 6 d group. The only difference in total born alive between the two extenders was in the 4 to 5 d group (Kuster and Althouse, 1999). These preliminary results have yet to be confirmed with another study.

Even more exciting is data on a new extender suggesting it is possible to store semen at 15°C for up to 7 – 12 days and still achieve a farrowing rate above 85% and litter size above 10. These results are quite preliminary and further research is needed in order to verify this, however the industry is headed towards true long term extenders that will improve production flexibility and reduce costs.

Temperature Management of Boar Semen

Proper temperature management for boar semen is essential during all phases of the AI process, whether you collect your own boars or purchase semen. Inappropriate changes in temperature during cooling, transport, storage or usage can negatively affect fertility. Boar sperm are extremely sensitive to chilling below 15°C resulting in the current practice of storing of boar semen at 17-18°C. This limitation has prevented progress in either developing methods to store liquid boar semen at lower temperatures or to cryopreserve boar semen.

Extending the range of useful storage temperatures, especially towards 5°C, would reduce the costs of AI in two ways. First, sperm metabolism slows as temperature is decreased thus cooler temperatures should increase the fertile storage time of the sperm. Second, 5°C refrigerators are widely available and are less expensive than specialized coolers. Shipping in a 5°C refrigerated unit would provide far greater protection from temperature fluctuations than a non-electric conventional cooler attempting to maintain 17 - 18°C.

Storing boar semen at 17 - 18°C presents many limitations and problems, the primary one being improper temperature changes during cooling, transport, storage or usage can often go unnoticed. The optimum situation is a gradual decrease in temperature to the storage temperature, a constant temperature during storage and a gradual increase in temperature just prior to insemination. This minimizes the metabolic activity of the sperm and extends the time that adequate fertility can be maintained during storage. If the storage temperature fluctuates up and down, sperm metabolism also fluctuates up and down. This increases the utilization of nutrients in the extender and reduces the useful life of the sperm. The cardinal rule is the temperature change of boar semen should be in one direction only until it reaches the desired temperature. Never reverse the direction of the change in temperature.

As the extended semen is cooled down to room temperature, it must be protected from draughts and light. After packaging, some semen will be either immediately used or stored at 17-18°C. Much of it though, will be immediately loaded into shipping coolers and transported. This may be an advantage in achieving a proper cooling rate as the temperature of this warm semen will continue to fall thus ensuring a single direction in the change in temperature. It is important to consider though, what factors influence the temperature the semen will reach during transport. Electric coolers will achieve their setpoint and continue to cool the semen to 17-18°C over time.
However, if the warm semen is placed into a non-electric cooler, what will the final temperature be? Will the semen in the cooler continue to cool or will the temperature simply stay at the temperature the semen was at when placed into the cooler? Is the cooler insulation sufficient to prevent the interior temperature from changing in response to changes in the outside temperature? Preliminary work has demonstrated that including gel cool packs in a non-electric cooler with the semen improves the viability of the semen after a shipping period of 24 hours. The beneficial effect was greater in styrofoam coolers than in plastic coolers (Flowers, 1996).

During storage, temperature fluctuations in the storage cabinet must be avoided. Check on-farm coolers daily. Some cooling cabinets cannot maintain their set temperature when exposed to extremes in ambient temperature such as daytime barn temperatures during the summer. These temperature fluctuations may be missed if the cabinet is checked only in the morning following the cooler evening. Use of a high-low thermometer is recommended.

When removing semen from storage for insemination, never allow the semen that is warming up to cool again. Remove from the storage cabinet only the semen you can use in 45-60 minutes and keep it in a styrofoam cooler with a gel pack from the storage cabinet. This will prevent warming of the semen until you are ready to use it. Potential temperature threats in the breeding barn include draughts and any surface you may set the insemination dose on. Again, temperature change should be in only one direction.

Extended boar semen is typically stored at 17 - 18°C because any drop below 15°C has reduced fertility. One of the factors that may influence final storage temperature may be the method of cooling the semen. Weitze et al. (1999) cooled extended boar semen from 35 to 5°C directly or in a series of 10°C steps. The motility and normal morphology of the sperm were reduced below acceptable levels in both cases, but the decrease was much less in the stepwise cooled sperm than in the directly cooled sperm. Additionally, incubation of the semen before decreasing the temperature to 5°C also had an effect. The reduction in motility and morphology was less with increased incubation times and incubating at 20°C appeared to be more effective than incubating at 25 or 15°C (Weitze et al., 1999). It is important to note that while these results suggest lower storage temperatures may be possible, they are microscopic values only and do not include fertility data at this time.

A study by Althouse et al. (1998) demonstrated that boar semen can be stored at 12°C in Androhep® while maintaining adequate fertility. Semen motility was reduced when stored for 48 hours at 12°C but the levels (~75% motile) were still within the minimum values usually recommended for AI. Storing at 10°C for 48 hrs resulted in sperm motility below minimum acceptable values. Semen that had been stored at either 17 or 12°C for ≤ 60 hrs was used to inseminate a total of 135 sows. Results for 17 vs 12°C storage were: farrowing rate: 95 vs 93 %; total born: 11.61 vs 11.58; total born alive: 10.63 vs 10.68. None of these differences were significant (Althouse et al., 1998). These results are promising but are preliminary and it is very important to note that they are applicable only for semen stored ≤ 60 hrs in Androhep®.

Extender data previously mentioned that suggested it is possible to store semen at 15°C for up to 7 – 12 days and still achieve adequate fertility also includes data for semen stored at 5°C for up to 7 – 12 days. Farrowing rates were above 84% and litter size above 10. Again, these results are very preliminary and further research is required.

Preliminary results appear to indicate that the current limitation in storing boar semen below 15°C may be overcome. Further research will determine if boar semen can be stored in a
refrigerator at 5°C, thus eliminating many of the technical issues present at 17-18°C as well as reducing the cost of AI.

The future of AI is that it will remain an important tool in increasing efficiency in modern production systems. How this technology will change in the next several years in order to improve efficiency even further remains unknown. Recent developments though, indicate that changes which may occur in the next few years will reduce the technical demands of the process as well as make it more economical.

References


