Mitigation of heat stress via scrotal insulation on spermatogenesis in boars with PG600

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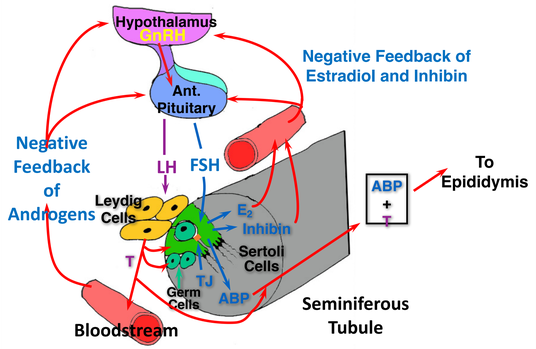
Introduction

- Boar scrotal temperature is 2-5°C cooler than core body temperature.
- Elevated environmental temperature can raise testicular temperature negatively impacting spermatogenesis reducing semen quality.
- Summer infertility costs the swine industry $420 million annually and is expected to increase due to climate change.
- Swine are especially vulnerable as 99% of semen is used within 1 to 5 days making collection during favorable seasons to use later difficult.
- Current cooling methods are not applied sufficiently to mitigate the negative effects of heat stress on spermatogenesis due to cost. Exploration into new methods, including pharmaceuticals is necessary.
- PG600, a drug, is human chorionic gonadotropin (HCG) and equine chorionic gonadotropin (ECG) which have LH- and FSH-like effects respectively. During spermatogenesis, LH impacts testosterone production by Leydig cells and FSH impacts Sertoli cells to produce androgen receptors, inhibit apoptotic signals and sustain spermatogenesis.



Objective

- The objective of this study is to test if the utilization of PG600 can mitigate the effects of heat stress on spermatogenesis in boars.
- Hypothesis: PG600 can mitigate heat stress in boars.

Methods

Eight boars were randomly assigned to two treatment groups: SI + saline or SI + PG600. SI was applied for 48 hours and injections were administered at two time points: 24 hours prior to the application of scrotal insulators and at the onset of insulation. PG600 was given at standard doses given to gilts to induce puberty (400 IU eCG and 200 IU hCG). Semen was collected every M-W-F for two weeks prior to treatment and 44 days post treatment. Semen was evaluated for nuclear head shape via Fourier harmonic analysis (FHA) described as Harmonic amplitudes 0-5 (HA0-5). The semen for each collection day post-treatment was compared to the average of the semen collection days pre-treatment, described as day 0.

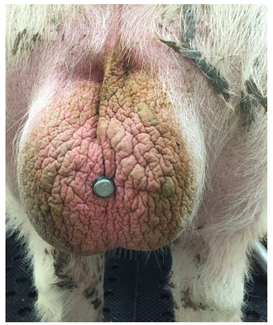
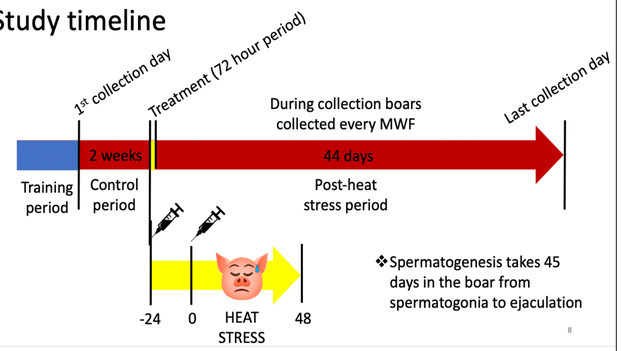


Figure 1. Left – An iButton affixed to the scrotum on a boar to monitor scrotal temperature. Right – A custom scrotal insulation sack affixed to the boar's scrotum. The insulating sack continues between the boar's hind legs to his prepuce to cover the pampiniform plexus, blocking counter-current heat exchange.

Study timeline



Results

Effect of Insulation on Scrotal Temperature

	Control	Insulation
Surface Measurement	33.0 ± 0.6°C N=4	36.5 ± 0.6°C N=8

*Difference between control and insulation, p<0.0001

Figure 2. The average temperature over the 48 hour insulation period in insulated and non-insulated boars. A 3.5°C scrotal temperature increase was seen in insulated animals.

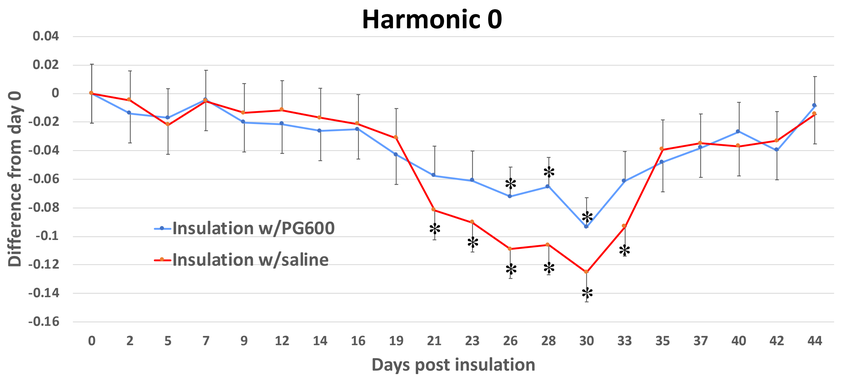


Figure 3. As an example Harmonic Amplitude 0 of sperm nuclei for scrotal insulation boars with PG600 injections (n=4) or saline injections (n=4) is shown. Pre-treatment ejaculates are averaged to represent day 0. Collection days for the PG600 or saline injected boars with an asterick (*) differ from day 0 (p<0.05). Other harmonics displayed similar results, described further below.

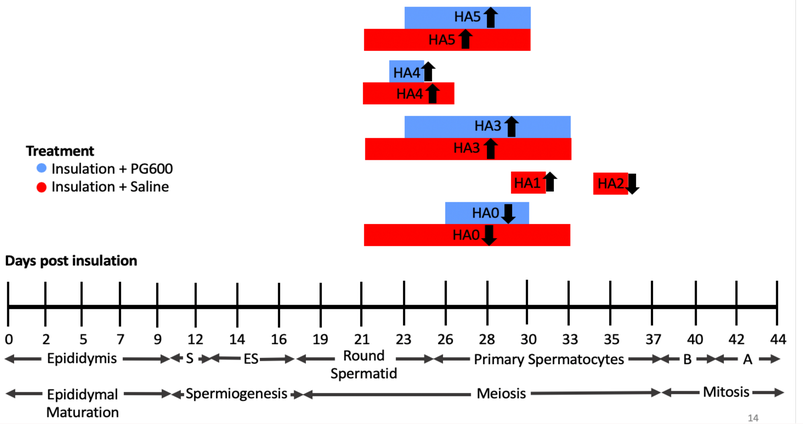


Figure 4. Effects on all harmonic amplitudes that had differences (p<0.05) in days post-treatment compared to day 0, an average of pre-treatment ejaculates. The respective developing germ cells types and biological processes associated with each day post-insulation are also shown.

Results Summary

- Scrotal insulation produced a 3.5°C increase in average scrotal temperature for 48 hours (p<0.0001)
- Increased scrotal temperature caused HA0 to decrease days 21-33 (p<0.05), HA1 to increase day 30 (p<0.05), HA2 to decrease day 35 (p<0.05), HA3 to increase days 21-33 (p<0.05), HA4 to increase days 21-26 (p<0.05), and HA5 to increase days 21-30 (p<0.05) in boars with saline treatment.
- Increased scrotal temperature caused HA0 to decrease days 26-30 (p<0.05), HA3 to increase days 23-33 (p<0.05), HA4 to increase day 23 (p<0.05), and HA5 to increase days 23-30 (p<0.05) in boars with PG600 treatment.
- Treatment with PG600 decreased the days for which changes in harmonic amplitudes were seen (p<0.05) as well as the magnitude of the response.

Conclusion

- PG600 was able to partially mitigate the response of boars to scrotal insulation and testicular heat stress.
- Increased doses may improve results as this was the first time PG600 was utilized in boars.

Acknowledgements

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