An innovative new tool to boost semen fertility and reduce costs

The use of artificial insemination (AI) with fresh semen is one of the key tools that established the basis of exponential growth in world pork production in recent years.

AI is an economical and easy technique to use and that explains its success in pig farms of any size. Despite these indisputable advantages, some aspects of AI may still be improved.

by S. Balasch, Grup Gepork SA, Barcelona, Spain.
www.gepork.com

One of the key points that have an impact on AI is the presence of a strong seasonality that affects fertility and prolificacy results. In Europe there is a noticeable decrease in reproductive parameters in commercial farms during summer and early autumn.

These effects have been attributed to several parameters like the increase in temperature that especially influences the females but also alters the boar's semen production or the existence of some seasonal cycle that affects sperm production. Notwithstanding, the mechanical bases of this phenomenon are not fully elucidated yet.

Furthermore, there are some aspects of the boar to consider, such as intrinsic values (age, breed, testicular size, etc) and extrinsic values (sperm handling, nutrition, rhythm of semen collection).

Application of light

Different research performed during the last few years found that the application of laser light-beams at low energy (wavelength ranging from 530-830nm) induces an increase in motion parameters and in ATP content in mouse, human, dog, bull, sheep and rabbit sperm.

These results showed that some variations in reproductive performance could be partially overridden through a light treatment (photo-stimulation) of sperm samples prior to AI. Although the molecular details of cell activation by the means of specific wavelength of visible light have not been fully understood, the current data suggest changes in the internal cell levels of Ca 2+ and the activation of mitochondria.

Beyond these previous laboratory data, in order to find a real solution, it was necessary to find the optimum photo-stimulation procedure for mammalian sperm and implement it in a practical tool, compatible with the routine farm workflow.

In this scenario, different research and development activities were performed.

Continued on page 15

Table 1. In vitro viability following incubation at 37°C.

Time (minutes)	Control	maXipig	Significance
0	93.5 ± 2.0%	92.1 ± 1.6%	NS
15	92.8 ± 2.4%	93.0 ± 1.1%	NS
30	92.1 ± 1.9%	93.0 ± 2.1%	NS
60	66.8 ± 1.0%	90.5 ± 1.9%	*
90	60.3 ± 1.2%	94.6 ± 2.3%	*

Table 2. In vitro acrosome integrity following incubation at 37°C.

Time (minutes)	Control	maXipig	Significance
0	95.0 ± 2.1%	95.8 ± 2.3%	NS
15	94.1 ± 2.0%	95.8 ± 2.3%	NS
30	93.7 ± 1.5%	95.0 ± 1.9%	NS
60	85.1 ± 1.1%	96.3 ± 2.4%	*
90	70.7 ± 1.1%	92.8 ± 2.5%	*

Fig. 1. Difference between range groups of fertility index farms.

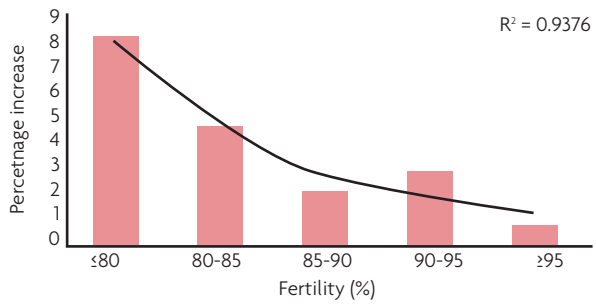
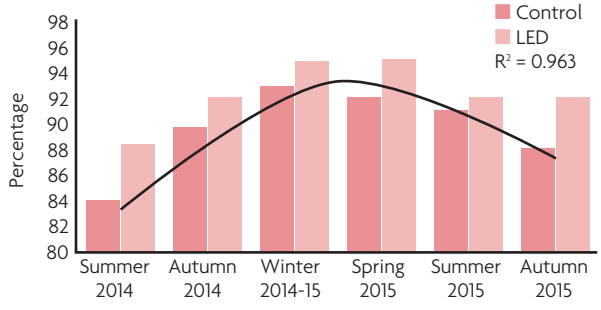


Fig. 2. Total % fertility by season.



Time (minutes)	Control	maXipig	Significance
0	95.2 ± 2.2%	95.4 ± 2.1%	NS
15	62.1 ± 6.4%	67.9 ± 7.8%	NS
30	62.8 ± 5.1%	63.0 ± 6.1%	NS
60	45.9 ± 6.2%	67.9 ± 6.0%	*
90	41.8 ± 6.7%	79.6 ± 7.0%	*

Table 3. In vitro total motility following incubation at 37°C.

Treatment	N	Farrowing rate (%)	Total piglets at parturition	Live born piglets at parturition
Control	800	83.7	13.5 ± 0.2%	12.7 ± 0.2%
maXipig	520	88.1*	14.9 ± 0.3%*	13.5 ± 0.2%*

Table 4. In vivo fertility parameters of boar sperm ejaculates with maXipig treatment (N = number of sows, *significance).

Continued from page 13
The aim was to find a tool that minimised the effects of seasonality and maximised fertility on AI in commercial farms.

In this article, a summary of the results that relate to pig reproduction is shown.

In vitro tests

The in vitro assays were performed in the Department of Animal Medicine and Surgery at the Autonomous University of Barcelona and in the Technosperm laboratory at the Universitat de Girona, using photoactivation systems from GenIUL.

Several tests were carried out with fresh commercial semen doses from Gepork. The doses were exposed to different patterns of red-light and different aspects regarding sperm viability were compared in a 90 minutes time frame. For the analyses of viability and acrosome integrity, flow cytometry was used; and the total motility was analysed with a CASA system.

Results showed a significant improvement in all parameters regarding sperm viability in a specific pattern of light-pause-light (Tables 1, 2 and 3). A first prototype of maXipig was developed to test these results in a commercial farm.

One farm in vivo trials

The test took place on a commercial farm located in Prats de Lluçanès (Catalonia, Spain) using fresh commercial semen doses, also provided by Gepork. A total of 1,320 sows were tested during a one-year trial, (between August 2014 and August 2015) using Pietrain and Duroc boars.

Each control and photo-stimulated batch of insemination included only multiparous sows (not gilts).

The first maXipig prototype was built to ensure the correct light irradiation of 25 fresh semen doses maintained during the 30 minutes process at a constant temperature of 17°C.

Results showed a significant improvement in fertility and prolificacy (Tables 4 and 5); increasing on average 4.4% the farrowing rate and 1.3 live born piglets at parturition.

After the first conclusions, eight more prototypes were developed to test these results in a wider scope, with almost 10,000 sows in commercial farms.

Multi farm in vivo trials

A total of 9,877 inseminations were done during the summer and autumn of 2015. All farms were located in Catalonia, using Pietrain, Duroc, Landrace and Large White breeds. Results showed a significant improvement in fertility and prolificacy. Better effects were observed in those farms in which in vivo fertility data were the lowest at the start of the procedure (Fig. 1).

This benefit is evident not only in seasonal periods in which fertility is affected (spring and summer), but also throughout the year (Fig. 2).

Results showed a significant improvement in fertility and prolificacy, increasing on average 2.3% the farrowing rate and 0.7 live born piglets at parturition (Table 6).

All nine farms are still working with the prototypes collecting data showing the improvements of light stimulation to boar sperm resistance, fertility and prolificacy. In all of them the workflow has been easily adapted to the use of this new tool.

A final version of maXipig will be available in October 2016 for commercial purposes. Built to be an easy to use and flexible unit, it is cost efficient with a quick ROI. This boar semen activation unit will surely be improving fertility in pig farms.

Conclusion

In conclusion, maXipig improves farrowing rates, prolificacy and boar semen resistance and viability parameters. As expected, any deleterious effects on the piglets were observed. This benefit is evident not only in seasonal periods in which fertility is reduced (spring and summer), but also throughout the year.

The greatest effects were observed on those farms in which fertility rates were below 90%, but all farms benefit from a significant increment. The use of maXipig in sow farms significantly reduces piglet costs by increasing both farrowing rates and prolificacy. ■

Contributing authors

Lleonart-Sitjar M.[2], Font-Santafè V.[2], Codony F.[3], Yeste M.[4,5], Bonet S.[5], Estrada E.[5], Peña A.[5], Rodríguez-Gil J.E.[5]

[2] IUL - maXipig, Torrent de l'Estadella 22, E-08030, Barcelona, Spain.

[3] GenIUL Rambla de Sant Nebridi 22, E-08222 Terrassa, Spain.

[4] Nuffield Department of Obstetrics and Gynaecology, University of Oxford, Level 3, Women's Centre, John Radcliffe Hospital, Headington, Oxford OX3 9DU, United Kingdom

[5] Biotechnology of Animal and Human Reproduction (TechnoSperm), Department of Biology, Institute of Food and Agricultural Technology, University of Girona, E-17003 Girona, Spain.

[6] Department of Animal Medicine and Surgery, Faculty of Veterinary Medicine, Autonomous University of Barcelona, E-08193 Bellaterra (Cerdanyola del Vallès), Barcelona, Spain.

Table 5. In vivo litter size of boar sperm ejaculates with maXipig treatment (Nb = number of births, *significance).

Treatment	Nb	Total piglets at parturition	Live born piglets at parturition
Control	3822	13.22	12.15
maXipig	2179	14.00*	12.85*

Table 6. In vivo farrowing rate of boar sperm ejaculates with maXipig treatment (*significance).

Treatment	Number of sows	Farrowing rate (%)
Control	6833	90.0
maXipig	3044	92.3*