



CIRCULAR BIOTECHNOLOGIES FOR GOAT REPRODUCTION: INTEGRATING ANIMAL WELFARE, SUSTAINABLE RESOURCE USE, AND *IN VITRO* EMBRYO TECHNOLOGIES



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INTRODUCTION & AIM

Sustainable dairy goat production requires strategies that support animal welfare, efficient resource use, and long-term genetic improvement. In the Netherlands, Saanen goats are frequently maintained in extended lactations of 2-4 years, and at the end of their productive lifespan, their reproductive tissues remain a potentially valuable source of genetic material.



Integrating post-mortem ovary recovery into *in vitro* embryo production systems offers a **circular approach** to utilizing these resources while **avoiding additional interventions** in live animals.

Furthermore, the **distribution of cryopreserved embryos** rather than **livestock** provides a welfare-friendly and biosecure method of genetic dissemination, **reducing transport-related stress and disease risks**.

This **preliminary study** evaluates the feasibility of **producing transferable embryos from elderly, long-lactating Saanen goats** within a circular and welfare-oriented reproductive framework.

METHOD

From October 2024 to November 2025, ovaries were collected from **12 Saanen goats aged 8-11 years (A)** at a **certified slaughterhouse** operating in compliance with Article 148 of Regulation (EU) 2017/2625 and Regulation (EU) 2016/429. **Cumulus-oocyte complexes were aspirated (B)**, matured *in vitro* (C), and fertilized with either fresh (n = 2) or cryopreserved semen (n = 10, D). **Zygotes (E) were cultured until Day 8** using standard IVP protocols. All viable embryos (F) were cryopreserved (G) for future non-surgical transfer within the Netherlands. **The blastocyst rate** was calculated as the percentage of presumptive zygotes that reached the blastocyst stage by Day 8 of culture.

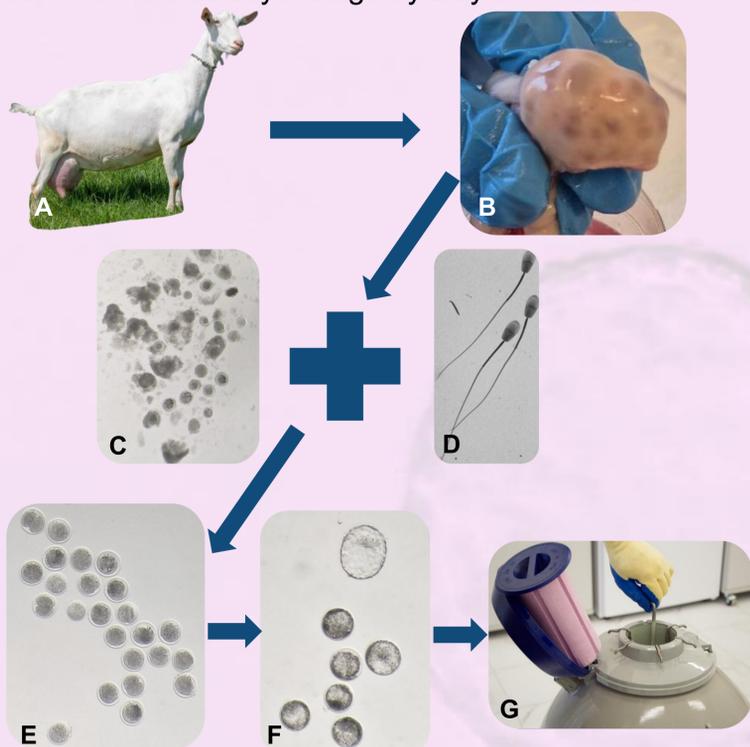


Figure 1. Scheme of the caprine *in vitro* embryo production.

RESULTS & DISCUSSION

Table 1 summarizes the efficiency of the caprine *in vitro* embryo production system. While oocyte recovery yielded a high initial number per donor, a developmental bottleneck was observed during the transition from the zygote to the blastocyst stage, impacting the final embryo yield per goat.

Table 1. Summary of caprine *in vitro* embryo production performance

Parameter	Total	Mean per goat (\pm SD)
Oocytes Recovered	354	30 \pm 7.6
Zygotes Produced	308	26 \pm 6.3
Blastocysts on Day 6	24	2 \pm 3.3
Blastocysts on Day 7	12	1 \pm 0.7
Blastocysts on Day 8	5	0.42 \pm 0.5
Total Blastocysts (D6-D8)	41	3.4 \pm 3.6
Overall Blastocyst Rate	13.3%	12.2 \pm 9.8

The use of **fresh semen** resulted in a blastocyst rate of **31.8%**, demonstrating strong developmental potential under standard conditions. In contrast, **cryopreserved semen** showed a reduced rate of **10.7%**.

The **high oocyte recovery** rate per donor indicates that **advanced maternal age and prolonged lactation** do not preclude the collection of a robust starting population for *in vitro* embryo production. These results demonstrate that the ovarian pool remains productive even in senescent animals, making **post-mortem oocyte aspiration** a highly efficient method for **recovering and preserving genetic material**. While these physiological factors may contribute to the developmental attrition observed between the zygote and blastocyst stages, the final yield represents an acceptable and clinically viable outcome for caprine assisted reproduction.

The majority of embryos reached the blastocyst stage early in the culture period, suggesting that the current environment is well-optimized for rapid development.

The **lower yield from cryopreserved semen** may indicate that these embryos require additional metabolic support to overcome early cleavage hurdles.

Despite these positive preliminary outcomes, further research is required. In particular, the obtained embryos must be transferred to recipients to evaluate their ability to establish pregnancy and develop into healthy kids.

CONCLUSION

These results demonstrate that **post-mortem ovaries from elderly Saanen goats** can produce **viable embryos via *in vitro* embryo production**.

This approach supports **circular economy principles**, reduces biological waste, preserves valuable genetics, and enhances **animal welfare** through embryo shipment instead of live animal transport.