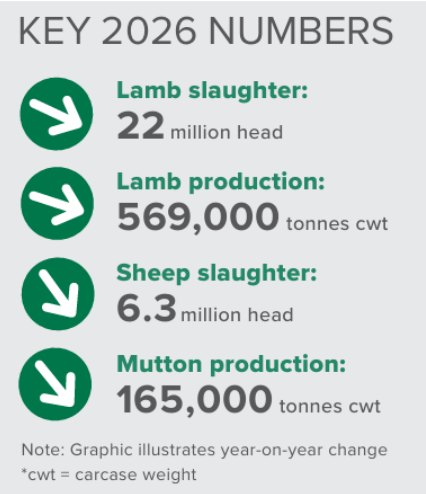
OCTOBER 2026

Sheep reproduction RD&A alert

This sheep reproduction RD&A alert is an initiative of the Sheep Reproduction Strategic Partnership (SRSP).

MLA have released their October Update of their Australian sheep Industry projections 2026. The update highlights that excellent seasonal conditions across southern Australia in 2026 have stabilised the flock. Lower sheep turn-off has tightened mutton availability, while productivity gains and larger carcase weights have supported lamb output. While export conditions remain mixed, tighter global supply continues to support demand for Australian sheep products.

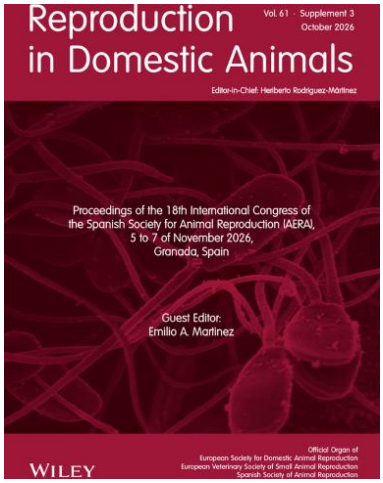


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MLA's Market Information Team have recorded a webinar to discuss the October Sheep Projections and provide an overview on the size of the national flock, slaughter rates, carcase weights, production volumes and exports of both lamb and mutton out to 2028. The team cover the current environment and the key drivers of Australian sheep supply in the short and medium term and outline what the remainder of 2026 and beyond holds for the sheep sector.

The SRSP aims to help sheep producers to profitability and sustainably increase lamb production through increasing lamb survival and weaning rates and will coordinate a national approach to improving sheep reproductive performance.

18th International Congress of the Spanish Society for Animal Reproduction (AERA)



This supplement of Reproduction in Domestic Animals (https://onlinelibrary.wiley.com/toc/14390531/2026/61/S3) contains contributions from the invited lectures, short communications and abstracts due to be presented at AERA in early November.

These contributions reflect all aspects of animal reproduction research including reproductive biology and physiology, gamete and embryo technologies, cryobiology, molecular and cellular mechanisms, biotechnology and reproductive management for a wide range of domestic species.

Review papers

Melatonin testicular synthesis and its role in reproductive physiology in seasonal and non-seasonal breeders

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Research in Veterinary Science, Volume 212, November 2026

DOI https://doi.org/10.1016/j.rvsc.2026.106397

Highlights

- Melatonin acts on seasonality, sexual hormone feedback and spermatozoa development.
- Melatonin local synthesis plays a role in pathways inside Leydig and Sertoli cells and spermatozoa.
- Melatonin regulates seasonal reproduction with different pathways in mammals testis.
- Local melatonin exerts antioxidant action on testicular tissue and spermatozoa development.
- Melatonin is a new target to improve reproduction in domestic and wild species.

Abstract

Melatonin (MT) is an indoleamine primarily produced by the pineal gland in a light–dark–dependent manner; however, it is also locally synthesized in the testis, where it influences male reproductive physiology upon interaction with its receptors (MT1/MT2), the binding started the bio-signaling inside the cells mediated by MT. This review outlines the intratesticular effects of MT, addressing seasonal and non-seasonal mammals. In rodents, Leydig, Sertoli, and germ cells contain enzymatic machinery to produce MT, with MT1/MT2 signaling influencing androgen production through cAMP-dependent and independent pathways and interacting with local Corticotropin-Releasing Hormone (CRH), serotoninergic, and catecholaminergic systems to regulate steroidogenesis and testicular plasticity. In non-seasonal species, Sertoli cells express MT1/MT2 and react to melatonin through alterations in proliferation, expression of spermatogenesis-related genes, and restructuring of glycolytic and acetate metabolism, thus modifying energetic support to germ cells. In seasonal breeders like rams and roe deer, MT1/MT2, N-acetyltransferase (AANAT), and acetylserotonin O-methyltransferase (ASMT) are found in testicular cells, spermatozoa, and the epididymis. Exogenous MT treatments are linked to advancements in the breeding season, increased testicular size and enhanced testosterone secretion in rams. MT1/MT2 were reported in spermatozoa from several seasonal and non-seasonal mammalian species and MT frequently was detected in seminal plasma, where they are involved in motility, capacitation, cryotolerance, and antioxidant protection. Therefore, suggesting that MT serves as a conserved but diversified intratesticular signal that integrates photoperiodic, metabolic, and cytoprotective regulation of male fertility.

Advances in semen extenders for small ruminant sperm preservation: Biological mechanisms and emerging strategies

Daniel Berean, Liviu Marian Bogdan, Ionela Ut and Raluca Cimpean

Animals, Volume 16, Issue 19, October 2026 **OPEN ACCESS**

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Simple Summary

Semen preservation is widely used in sheep and goat reproduction to support artificial insemination, genetic improvement, and conservation of valuable breeds. During cooling and freezing, sperm cells are exposed to several damaging factors such as cold shock, oxidative stress, osmotic imbalance, and ice crystal formation, which reduce sperm quality and fertility. Semen extenders are protective media added to semen to maintain sperm viability during storage and cryopreservation. Conventional extenders commonly contain buffers,

sugars, cryoprotectants, egg yolk, or milk proteins that help stabilize sperm membranes and reduce cryodamage. However, biological variability, contamination risks, and negative interactions between goat seminal plasma enzymes and animal-derived extender components remain important limitations. For this reason, recent research has focused on the development of alternative extender systems such as soy lecithin-based formulations, chemically defined media, antioxidants, synthetic membrane stabilizers, and nanotechnology-derived additives. These new approaches aim to improve sperm survival, extender standardization, and biosafety, although many remain under experimental evaluation. This review explains the biological mechanisms underlying semen preservation and discusses the advantages, limitations, and future prospects of conventional and emerging semen extenders for sheep and goats.

Abstract

Semen preservation represents a fundamental component of reproductive biotechnology in small ruminants, supporting artificial insemination programs, genetic improvement, germplasm conservation, and sustainable livestock production. However, ram and buck spermatozoa are highly susceptible to cryoinjury induced by cold shock, oxidative stress, osmotic imbalance, and membrane destabilization during cooling, freezing, and thawing procedures. Consequently, semen extenders play a critical role in maintaining sperm viability, motility, membrane integrity, mitochondrial activity, and fertilizing capacity during preservation. This narrative review summarizes the biological basis of sperm preservation in sheep and goats and discusses the principal conventional and emerging extender systems used in small ruminant semen cryopreservation. Conventional extender components, including buffering systems, energy substrates, cryoprotective agents, egg yolk, and milk proteins, are reviewed with emphasis on their mechanisms of action and protective effects against cryodamage. Particular attention is given to species-specific limitations associated with buck seminal plasma enzymes and their interactions with egg yolk- and milk-based extenders. In addition, recent advances involving chemically defined extenders, soy lecithin formulations, antioxidants, synthetic membrane stabilizers, and nanotechnology-derived additives are discussed as promising alternatives aimed at improving cryosurvival, reducing oxidative stress, and enhancing extender standardization and biosafety. Practical applications of semen extenders in artificial insemination and semen banking are also discussed together with current methodological limitations, species-specific challenges, and future research priorities. Although numerous emerging strategies have demonstrated promising improvements in laboratory sperm-quality parameters, evidence supporting consistent fertility benefits under field conditions remains limited. Overall, this review critically evaluates current knowledge and highlights the need for species-specific, protocol-oriented, and well-standardized approaches to advance semen preservation in small ruminants.

Balancing prolificacy and lamb meat production: Links among litter size, prenatal development, carcass traits, and meat quality in sheep

Song Guan, Dexin Zhao, Haoliang Chai, Linfeng Zhou, Weiqi Peng and Hongzhi Wu

Animals, Volume 16, Issue 19, October 2026 **OPEN ACCESS**

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Simple Summary

Increasing the number of lambs born per ewe can raise flock output, but a larger litter is useful only when the lambs survive and develop into marketable carcasses. Twins and triplets are usually lighter at birth because they share uterine space, placental supply, colostrum, and milk. The smallest lambs are therefore more vulnerable to cold, starvation, mismothering, and slow early growth. These disadvantages are most pronounced in triplet and larger litters, yet they do not mean that meat from multiple-born lambs is intrinsically poorer. When lambs are compared at a similar carcass weight and are managed under suitable feeding and slaughter conditions, differences in tenderness, color, water retention, fat content, and flavor

are often limited or inconsistent. The main effect of litter size is usually on survival, growth rate, and the time needed to reach slaughter. Farmers can reduce these losses by scanning ewes for fetal number, feeding them according to pregnancy demand, safeguarding colostrum intake, fostering or artificially rearing surplus lambs when needed, and grouping lambs by weight after weaning. Breeding programs should likewise avoid selecting the litter size alone. The most useful goal is a manageable number of vigorous lambs that produces more saleable meat per ewe without unacceptable costs to animal welfare, labor, feed use, or product uniformity.

Abstract

Prolificacy can increase lamb output per ewe, but its productive value depends on the survival, growth, and carcass performance of each additional lamb. This review examines the pathway from genetic control of ovulation to realized litter size, prenatal development, neonatal viability, postnatal growth, carcass traits, and meat quality. Major fecundity genes, including *BMPR1B*, *BMP15*, *GDF9*, and *B4GALNT2*, alter ovulation rate, although evidence for direct effects of these loci on muscle development or meat quality remains scarce. Most phenotypic differences are more plausibly mediated through fetal number and the maternal environment. Compared with singletons, multiple-born lambs generally have less placental tissue per fetus, lower birth weight, reduced neonatal vigor, and slower preweaning growth. Prenatal restriction may alter myofiber formation, adipogenesis, and connective tissue development, but its later expression depends strongly on postnatal nutrition and slaughter endpoint. Across studies, litter size has a clearer and more consistent association with survival, growth trajectory, and carcass readiness than with ultimate pH, color, water-holding capacity, tenderness, intramuscular fat, fatty acid composition, or sensory quality. Reported contrasts vary with age, diet, carcass weight, and fatness; adjustment can attenuate some observed differences, but it may also remove effects mediated through growth. An effective production strategy therefore targets optimum rather than maximum prolificacy. Genetic selection should be integrated with pregnancy diagnosis, fetal-number-specific nutrition, colostrum management, rearing allocation, targeted finishing, and carcass feedback, with performance evaluated as saleable carcass output per ewe. The evidence is primarily observational for natural birth-type comparisons, while controlled nutritional models support selected prenatal mechanisms rather than equivalence to natural multiple pregnancy.

Cryopreservation of ram semen: A review on the roles of emerging synthetic and natural additives

Christopher Dale LeBrun, Martin Ptáček, Barbora Šedivá, Tomáš LeBrun, Lucie Langerová and Filipp Georgijevič Savvulidi

Animals, Volume 16, Issue 20, October 2026 **OPEN ACCESS**

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Simple Summary

Artificial insemination using frozen ram semen is an important tool for sheep breeding and genetic conservation, but the freezing and thawing processes can cause severe damage to sperm cells. Traditional semen extenders rely heavily on egg yolk and glycerol to help protect the sperm cells, but they carry contamination risks and often lead to poor post-thaw fertility results. In order to overcome these issues, current studies are investigating novel natural and synthetic additives to assist in protecting cell membranes and reduce oxidative damage. These additives include plant extracts, vitamins, amino acids, hormones, sugars, and lipids. This review analyzes recent advancements in semen extender supplementation and highlights promising compounds. Furthermore, it identifies important research gaps such as dose standardization and long-term storage stability. Advancing these extender formulations will improve the success and reliability of reproductive technologies in sheep and other livestock species.

Abstract

Cryopreservation techniques and protocols for ram semen, particularly those with a focus on semen extender additives, have gained popularity recently, as many scientists are looking for ways to mitigate cryodamage and improve post-thaw sperm quality. The purpose of this structured narrative review was to examine studies published in 2019–2024 on both synthetic and natural additives, to separate evidence obtained in rams from comparative evidence in other species, and to analyze current trends and potential gaps for future research. Cryopreservation is an indispensable aspect in livestock production and conservation of genes using artificial insemination. Nevertheless, the freezing and thawing processes result in DNA fragmentation, oxidative stress and low sperm motility, which are detrimental to reproductive success. Conventional extenders that contain glycerol or egg yolk have been used extensively to support cell membranes and prevent the formation of ice crystals. Nevertheless, the fertility rates obtained from frozen–thawed ram semen have been poor, which has led to the investigation of other substances. Natural additives like plant polyphenols, vitamins, fatty acids and sugars have shown great potential to decrease free radicals and enhance sperm integrity. Synthetic additives, including Trolox, MitoQ, and Mito-TEMPO, were also found to enhance the antioxidant capacity. Over the past few years, some trends have emerged, including an increased interest in plant-based antioxidants and nanoparticle-based additives. Nevertheless, several research gaps were observed, including the need for further optimization of the additive dose ratios, availability of studies on the stability of these additives when used long-term, and the compatibility of extender formulations across breeds and species. This review synthesizes recent developments in ram semen cryopreservation additives; for most additives, the evidence is presented in a single study with sperm-quality endpoints. Few studies measured in vivo fertility. It emphasizes the necessity of shifting from descriptive additive studies to mechanism-focused protocols validated across breeds to enhance the scalability and reliability of reproductive biotechnologies.

Scientific papers

Targeted post-weaning intervention of weaners with low growth rate pre-weaning is a profitable strategy to increase the productivity of Merino sheep

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Animal Production Science, Volume 66, Issue 15, October 2026 **OPEN ACCESS**

DOI https://doi.org/10.1071/AN25456

Abstract

Context The post-weaning period is critical for the lifetime productivity of Merino sheep, yet weaners with low weaning weights present a significant management and economic challenge for producers. Strategies to mitigate poor performance in these ‘tail-end’ animals are essential for improving overall flock efficiency.

Aims This study aimed to evaluate the biological and economic merit of preferentially feeding and managing Merino weaners with a low growth rate pre-weaning to enhance their bodyweight and wool production, and to determine whether any production gains were maintained post-treatment.

Methods In total, 332 Merino weaners were separated 1 week after weaning at 3 months of age into the following three groups for a 14-week period: a group of low growth pre-weaning (LOW), a group of high growth pre-weaning (HIGH), and a mixed high and low growth pre-weaning control group (CTRL). The LOW group received a supplement averaging 200 g/head.day (provided three times per week) and fortnightly anthelmintic treatments. The HIGH and CTRL groups were managed under industry best practice. Bodyweight, growth rates, and wool characteristics were measured.

Key results The LOW group exhibited significantly higher growth rates (70.5 ± 2.0 g/day; $P < 0.0001$) during the treatment period (Period 1), demonstrating effective compensatory growth. Consequently, the LOW

group attained a significantly greater final bodyweight. During the subsequent combined-management period (Period 2), the LOW group had lower growth rates but maintained their bodyweight advantage. At 9 months of age, the LOW group produced a heavier greasy fleece (1.67 kg; P < 0.001). The preferential management strategy yielded a net profit of A$6.24 per head across the whole flock, when comparing the production gains of the LOW and HIGH groups combined against the costs of preferentially managing the LOW group, relative to the CTRL group.

Implications Preferential management through targeted supplementary feeding and intensive parasite control is an effective and economically viable strategy for improving the bodyweight and wool production of underperforming weaner sheep. This intervention allows low growth-rate weaners to surpass their high growth-rate counterparts.

Repeated low-dose lipopolysaccharide exposure during the periconception period on ewe immune responses and lamb performance

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Journal of Animal Science, Volume 104, October 2026 **OPEN ACCESS**

DOI https://doi.org/10.1093/jas/skag296

Abstract

Subclinical inflammatory challenges caused by gram-negative bacterial endotoxin lipopolysaccharide (LPS) may disrupt reproductive physiology and influence offspring development; however, the effects of repeated low-dose exposure during the periconception period remain unclear. Therefore, this study evaluated the effects of repeated low-dose LPS exposure on maternal immune and endocrine responses, reproductive performance, and offspring growth and development. Rambouillet ewes (n = 30; 2–8 yr; 61 ± 6 kg BW) were stratified by body weight and age and assigned to receive subcutaneous injections of saline (CON; n = 10), 1.5 µg/kg BW LPS (LOW; n = 10), or 3.0 µg/kg BW LPS (HIGH; n = 10) on d 5, 10, and 15 of a synchronized estrous cycle prior to breeding. Rectal temperature, serum cortisol, and complete blood count (CBC) parameters were measured before and after LPS administration, with repeated measurements collected through 24 h following treatment. Reproductive performance was evaluated after a 35-d breeding season, and lamb hematology, growth, morphometric traits, and wool characteristics were assessed from birth through weaning (d 60) and repeated-measures outcomes were analyzed using mixed-effects models. Maternal LPS exposure increased rectal temperature and serum cortisol on day 5 (treatment × hour, $P \leq 0.05$). Cortisol responses remained elevated across repeated exposures (treatment × hour, $P \leq 0.05$), but rectal temperatures did not differ on subsequent LPS challenge days. Total white blood cell, and lymphocyte concentrations decreased 2–4 h after treatment and increased at 24 h on d 5 (treatment × hour, $P \leq 0.05$). Red blood cell and platelet parameters were minimally affected by treatment. Maternal LPS exposure did not affect conception rate, pregnancy rate, or lamb production traits. However, offspring from LOW-treated ewes had greater total white blood cell, lymphocyte, and neutrophil concentrations at birth and increased neutrophil concentrations at d 14 ($P \leq 0.05$), but these differences were not maintained through weaning. No treatment effects were detected for lamb growth, morphometric development, or wool characteristics. Collectively, these results indicate that repeated low-dose maternal LPS exposure during the periconception period alters maternal immune responses and is associated with transient alterations in neonatal white blood cell profiles without affecting reproductive performance or growth outcomes.

Stage-specific associations between respiratory pathogens and mortality in sheep: A multivariate analysis

Antonio Romero-Salmoral, Manuela Hernández-García, Francisco Javier Navas González, Carmen Tarradas Iglesias, Belen Huerta Lorenzo, Inmaculada Luque Moreno, Eva Boyer-Bustamante and Francisco Jurado-Martos

Animals, Volume 16, Issue 19, October 2026 **OPEN ACCESS**

DOI https://doi.org/10.3390/ani16193028

Simple summary

Ovine respiratory disease is one of the main causes of lamb mortality and reduces animal welfare and farm profitability. However, it remains difficult to identify which microorganisms are most strongly associated with deaths at different production stages because several pathogens are commonly found in healthy animals. Here, we analyzed lung wash samples from 200 apparently healthy lambs from commercial sheep farms in Spain and compared the presence of the main respiratory pathogens with mortality rates recorded on farms and in feedlots using a multivariate statistical approach. Our analyses showed that *Mesomycoplasma ovipneumoniae* and *Pasteurella multocida* were mainly associated with on-farm mortality, whereas *Mannheimia haemolytica* was the principal pathogen associated with feedlot mortality. These findings demonstrate that the importance of respiratory pathogens changes throughout the production cycle and highlight the need for stage-specific health monitoring and effective vaccination of ewes against the isolates circulating within farms, and management strategies to reduce lamb mortality, improve animal welfare, and enhance the sustainability of sheep production.

Abstract

Ovine Respiratory Complex (ORC) is a major cause of lamb mortality in intensive and semi-intensive sheep production systems. Its multifactorial etiology, involving bacterial and viral pathogens together with host and environmental factors, complicates disease control and limits the effectiveness of conventional preventive measures. Although respiratory pathogens are commonly detected in healthy lambs, their contribution to mortality at different production stages remains poorly understood. This study evaluated the relationships between respiratory pathogens and lamb mortality using canonical multivariate analysis. A total of 200 bronchoalveolar lavage samples were collected from apparently healthy lambs aged 50–60 days during winter (n = 80) and summer (n = 120) on 10 commercial sheep farms in southwestern Spain. Samples were analyzed by real-time PCR for the detection of major bacterial and viral respiratory pathogens, and mortality records from farms and feedlots during 2022–2023 were incorporated into the analysis. A high herd-level prevalence was detected for *Pasteurella multocida*, *Mannheimia haemolytica*, *Bibersteinia trehalosi*, and *Mesomycoplasma ovipneumoniae*, whereas *Histophilus somni*, Orf virus, and parainfluenza virus type 3 showed intermediate prevalence. No significant seasonal differences were observed in pathogen prevalence. ORC-associated pathogens accounted for approximately 20% of the variance in mortality, suggesting that non-infectious factors also play an important role in lamb losses. Canonical analysis identified stage-specific multivariate patterns, with *M. ovipneumoniae* and *P. multocida* contributing most strongly to the canonical dimension characterized by on-farm mortality, whereas *M. haemolytica*, together with *P. multocida* and parainfluenza virus type 3 (PIV3), contributed most strongly to the dimension characterized by feedlot mortality.These findings improve our understanding of the epidemiology of ORC and support the development of targeted surveillance, prevention, effective vaccination of ewes against the serotypes circulating within farms, and management strategies to reduce lamb mortality, improve animal welfare, and enhance the sustainability of sheep production.

Interactive effects of seminal plasma and *Sonchus oleraceus* L. aqueous extract on post-thaw sperm kinematics, oxidative status, and in vitro fertilization outcomes in ram semen

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Animals, Volume 16, Issue 19, October 2026 **OPEN ACCESS**

DOI https://doi.org/10.3390/ani16193042

Simple summary

Cryopreservation of ram semen is an important tool in animal reproduction; however, spermatozoa are susceptible to cryodamage during the freezing–thawing process, which may compromise their functional quality and fertilizing capacity. This study investigated whether removing seminal plasma and adding a plant extract from *Sonchus oleraceus* could improve the quality of cryopreserved ram semen. Semen samples were divided into different groups depending on the presence or absence of seminal plasma and different doses of plant extract, then frozen and later thawed for analysis. Sperm quality was evaluated using computer-assisted analysis, membrane integrity tests, and measurements of oxidative stress indicators, as well as in vitro fertilization performance. The results showed that removing seminal plasma improved some movement characteristics of sperm but also increased cellular damage caused by oxidative stress. In contrast, supplementation with *Sonchus oleraceus* extract reduced this damage, improved sperm membrane integrity, and restored the balance between harmful and protective molecules. However, *Sonchus oleraceus* aqueous extract supplementation did not affect in vitro embryo development. Overall, this study suggests that plant-based antioxidants may help improve ram semen quality during cryopreservation and support more efficient assisted reproduction techniques in sheep breeding.

Abstract

This study investigated the combined effects of seminal plasma (SP) and *Sonchus oleraceus* L. aqueous extract on post-thaw sperm quality and fertilizing ability in rams. Semen collected from seven adult rams was pooled and divided into six experimental groups according to the presence (SP+) or absence (SP−) of SP and supplementation with 0, 0.5, or 2 g/L of *Sonchus oleraceus* extract. Samples were cryopreserved in a Tris–egg yolk–citric acid extender. Post-thaw sperm quality using computer-assisted sperm analysis (CASA), hypo-osmotic swelling (HOS) test, and oxidative stress biomarkers, including reactive oxygen species (ROS), malondialdehyde (MDA) and total thiols as antioxidative parameter were evaluated. Removal of SP significantly enhanced several kinematic parameters (VCL, ALH, DCL) and reduced abnormal morphology ($p < 0.05$), whereas its presence improved motion quality indicators such as beat cross frequency (BCF), linearity (LIN), and straightness (STR) ($p < 0.05$). However, SP removal induced a marked oxidative imbalance, characterized by increased ROS and MDA levels and decreased total thiols ($p < 0.001$). Supplementation with *S. oleraceus* extract improved membrane integrity and restored redox balance by increasing thiols levels ($p = 0.0001$) and reducing lipid peroxidation ($p < 0.001$), with significant SP × dose interactions. Based on these results, in vitro fertilization (IVF) was performed only using SP+ groups, as the presence of SP ensured a more physiologically relevant environment and maintained oxidative balance necessary for fertilization. No significant differences were detected in cleavage or blastocyst rates among the three *S. oleraceus* extract doses. These findings highlight an interaction between SP and *Sonchus oleraceus* aqueous extract, suggesting that combining endogenous protein-rich components with exogenous plant-derived antioxidants may enhance post-thaw sperm functionality and its oxidative status in rams.

Evaluating the relationship between infrared thermography and somatic cell count in healthy lactating ewes

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Research in Veterinary Science, Volume 12, November 2026

DOI https://doi.org/10.1016/j.rvsc.2026.106411

Highlights

- Mammary IRT was evaluated in clinically healthy lactating dairy ewes.
- Udder surface temperature was not associated with milk SCC levels.
- IRT alone showed limited value for monitoring physiological variation in milk SCC.
- Integration of IRT with complementary diagnostic approaches may improve udder health assessment.

Abstract

Infrared thermography (IRT) is a rapid, real-time, and non-invasive technique that measures surface temperature by detecting infrared radiation emitted by body tissues. Its use has been increasingly investigated as a diagnostic tool for assessing udder inflammation. The objective of this study was to evaluate the relationship between mammary surface thermal response and milk somatic cell count (SCC) in healthy lactating ewes. The study involved 44 healthy lactating ewes (88 udder-halves). A preliminary SCC sampling was performed to select animals covering a wide range of SCC values. Udder infrared thermal images were acquired using a FLIR T650sc camera before milking, concurrently with the collection of individual udder-half milk samples for SCC determination. SCC from the second sampling, collected immediately after thermographic image acquisition, were used to evaluate the relationship with minimum (TMIN), mean (TMEAN), and maximum (TMAX) udder surface temperatures. SCC values were screened for outliers, and 15 udder-halves were excluded. Consequently, 73 udder-halves were retrospectively classified according to SCC as follow: low (<69,000 cells/mL), medium (69,000–163,000 cells/mL), high (163,000–384,000 cells/mL), and highest (>384,000 cells/mL). General linear mixed model (GLIMMIX) and Pearson correlation were performed. As expected, SCC differed among groups ($p < 0.001$). However, SCC classes did not influence minimum ($p = 0.06$), mean ($p = 0.60$) or maximum ($p = 0.85$) udder temperature. No correlations were found between SCC and TMIN ($r = -0.014$), TMEAN ($r = 0.005$), or TMAX ($r = 0.045$). Under the conditions of the present study, mammary IRT alone was not associated with variations in milk SCC in healthy lactating ewes.

Mechanical vaginal stimulation: Effects on estrous duration, follicular maturation, time of ovulation, and the luteinization process in ewes

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Small Ruminant Research, Volume 264, November 2026 **OPEN ACCESS**

DOI https://doi.org/10.1016/j.smallrumres.2026.107863

Highlights

- Mechanical vaginal stimulation reduced the length of estrus in ewes.
- Mating shortened the length of estrus in ewes through a mechanical effect.
- Mechanical vaginal stimulation reproduced the effects of mating in ewes.
- The effects of mechanical vaginal stimulation appear as influenced by the stage of the breeding season.

Abstract

Multiple mating shortens the length of estrus and improves corpus luteum quality, thereby increasing progesterone secretion during the early luteal phase. In goats, vaginal stimulation by the penis appears as the key mediator of those effects. The aim of this study was to determine whether mechanical vaginal stimulation during estrus reduces the length of estrus and enhances luteinization and progesterone secretion in ewes. Estrus was synchronized in 48 ewes across two experimental repetitions, with 24 animals per repetition. Estrus onset was monitored every 3 h using teaser rams, without allowing mating. At estrous detection, ewes were assigned to one of three groups: 1) Mating group, in which ewes were allowed to mate every 3 h until the end of estrus; 2) Control group, with no mating or stimulation; and 3) Mechanical Vaginal Stimulation (MVS) group, which received vaginal stimulation using an instrument that mimics the ram penis. Ovarian dynamics were assessed by transrectal ultrasonography every 3 h until ovulation and daily until 6 days after ovulation. Blood samples were collected every 24 h to determine serum progesterone concentrations. Treatment effects were observed during the second experimental repetition. Both the Mating and MVS groups showed a shorter estrous duration a reduced interval from estrous onset to ovulation, and a greater ovulatory follicle diameter compared with the Control group. In conclusion, under certain conditions mechanical vaginal stimulation reproduced the effects of mating by shortening estrus, promoting final follicular growth, and modifying ovulation timing, depending on the stage of the breeding season.

The impacts of maternal stress on placentome dynamics, uterine and umbilical arterial blood flow, and fetal birth weight in relation to vascular endothelial growth factor and nitric oxide levels in advanced pregnant ewes

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Highlights

- Placental diameter was increased in low-stressed ewes compared to the lack of observed change in high-stressed ones.
- Both uterine and umbilical arteries Doppler velocities and flow volume were decreased in high-stressed ewes with an elevation in both Doppler indices.
- Vascular endothelial growth factor and nitric oxide levels were decreased in high-stressed ewes.

Abstract

This study aimed to determine the impacts of maternal stress on placentome diameter (PD), lamb weight, uterine (U.A) and umbilical (UM. A) arterial vascular perfusion during the late gestation period in ewes with respect to progesterone (P4), nitric oxide (NO), and vascular endothelial growth factor (VEGF) levels. Fat-tailed Arab ewes were classified according to the Arena test into low-stressed control ewes (n = 7) and high-stressed ewes (n = 7) at day 100 of pregnancy. Ultrasonographic scanning and blood sampling were conducted every 10 days. PD was increased (P = 0.04) in low-stressed ewes, whereas no change occurred in high-stressed ewes. Dam and lamb weights were decreased in high-stressed ewes. Both U.A and UM. A diameters did not change in high-stressed ewes compared to the increase observed (P = 0.04) in low-stressed animals. U.A and UM. A Doppler velocities, and blood flow volume (BFV) were declined (P = 0.02) in high-stressed animals with an increase (P = 0.02) in Doppler resistance and pulsatility indices (RI and PI) from day 100 to day 140. P4 levels remained at their baseline level until day 130, then gradually declined; however, in stressed ewes, there was a sharp decrease (P = 0.03) in P4 levels. NO and VEGF levels declined (P = 0.02) in stressed ewes compared to an elevation in low-stressed ewes for NO with no change for VEGF. In conclusion,

maternal stress alters fetoplacental circulation (by the elevation in Doppler indices and the reduction in blood flow velocities), and angiogenic factors at parturition in ewes.

Effects of dietary supplementation with hemp cake and hempseed *(Cannabis sativa L.)* on the quality parameters and oxidative-antioxidative status of epididymal sperm in rams

Magdalena Koziorowska-Gilun, Paulina Pogorzelska-Przybyłek, Przemysław Gilun, Anna Dziekońska and Cezary Purwin

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Highlights

- Hemp-derived products did not affect the TMOT or PMOT of ram epididymal sperm.
- Dietary hemp supplementation improved the PMI and MMP of ram epididymal sperm.
- The combination of hemp seeds and cake had the strongest effect on sperm OS.

Abstract

Hemp-derived products are increasingly considered as alternative protein sources to soybean meal (SBM) due to their favorable amino acid composition, high digestibility, and potential antioxidant properties. This study evaluated the effect of dietary supplementation with hemp seeds and hemp cake on the quality parameters and oxidative-antioxidative status of epididymal sperm in rams. Twenty-four clinically healthy Polish Lowland ram lambs were assigned to four iso-nitrogenous dietary groups with different inclusion levels of hemp-derived products. The study demonstrated that hemp supplementation had no significant effect on the total motility (TMOT) or velocity parameters of spermatozoa. The sperm collected in the group fed SBM and hemp seeds at a 50:50 ratio exhibited higher straightness ($P < 0.05$), while their progressive motility (PMOT) only tended to increase. Hemp-based diets significantly ($P < 0.01$) improved mitochondrial membrane potential (MMP) and plasma membrane integrity (PMI). Superoxide dismutase (SOD) activity decreased, whereas glutathione peroxidase (GPx) activity and total antioxidant status (TAS) increased in the experimental groups. Moreover, total oxidant status (TOS) and the oxidative stress index (OSI) were reduced, particularly in the group fed hemp cake and hemp seeds at a 50:50 ratio ($P < 0.01$). The group receiving hemp cake and hemp seeds at a 50:50 ratio also showed a significant increase in MDA concentration ($P < 0.05$). Hemp-derived products supported sperm membrane functionality and the oxidant-antioxidant balance. These findings suggest that hemp feed ingredients, when included in appropriate proportions, can be effectively incorporated into ram diets and improve epididymal sperm quality parameters. This underscores the need for further research on their long-term effects.

One flock, four lactations: A longitudinal study of intramammary infections in meat-sheep production system

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Small Ruminant Research, Volume 264, November 2026 **OPEN ACCESS**

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Highlights

- Mastitis accounted for most of ewe losses over the 4-year study period.
- Most mastitis-related losses resulted from culling due to subclinical udder damage.
- Clinical *S. aureus* mastitis predominated in first-lactation ewes.
- Subclinical CNS infections increased in prevalence in Year 4.

- Few *S. aureus* genotypes were identified, indicating limited strain diversity.

Abstract

The economic and welfare impacts of intramammary infections make mastitis among the most significant diseases of dairy farming worldwide. However, mastitis in meat-producing sheep systems remains comparatively understudied. In this study we aimed to investigate the prevalence, temporal distribution and causative agents of intramammary infections in a meat sheep production system common in the UK. We followed the mammary health of 247 age- and breed-matched Scotch Mule ewes over their first four lactation cycles. Over the four lactations a total of 671 milk samples were collected at weaning or on occurrence of clinical mastitis. One-hundred and twelve bacterial isolates were derived from the milk samples with coagulase-negative *Staphylococci* representing 53.6% of the total, followed by *Staphylococcus aureus* (33%), *Mannheimia* spp. (7.1%) and *Streptococcus* spp. (4.5%) and *Escherichia coli* (1.8%). The proportion of subclinical to clinical disease changed significantly over years 1–4 with clinical disease more prevalent in Year 1 compared with subsequent years (6.3%, 1.7%, 2.9%, 2.2% respectively). Subclinical infections remained at similar levels for three lactation cycles before a significant increase in Year 4 (9.7%, 8.6%, 9.2%, 19.6%). Five *S. aureus* Multi-Locus Sequence Types (MLST) were identified including a novel sequence type officially named ST9241. No temporal change in MLST was found, but two types (ST1640 and ST1958) were exclusively associated with subclinical infections. These findings provide new insight into the prevalence and epidemiology of bacterial agents involved in intramammary infections in meat sheep and provides an archive of bacterial isolates to support future studies into mastitis pathogens.

Multilevel information encoded in ewes' and lambs' vocalizations across early postpartum period

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Applied Animal Behaviour Science, Volume 305, December 2026

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Highlights

- Lambs and ewes maintain vocal distinctiveness across postpartum period.
- Social isolation condition is strongly encoded in sheep vocalizations.
- Lamb calls encode sibling status under social isolation conditions.
- Litter size and sex are not encoded in vocal signatures of ewes and lambs, respectively.
- Temporal information (postpartum stages) is weakly encoded in ewes' calls.

Abstract

Vocal communication plays a dominant role in maternal bonding and offspring survival in sheep. However, little is known about how vocal individuality changes during development and whether biological information (sex, sibling existence etc.) are encoded within vocal signals. The aim of this study was to investigate the encoding of individual and biological information in the vocal responses of Chios breed ewes and lambs under conditions of total and partial isolation. High-quality calls were recorded from 19 ewes and 29 lambs (15 males, 14 females) under total and partial isolation, from the 10th to the 60th day postpartum. Twenty (20) acoustic parameters related to source, filter, intensity, and duration were extracted. These parameters were subjected to Principal Component Analysis (PCA), and the components with eigenvalues > 1 were utilized in Discriminant Function Analyses (DFAs and pDFAs) to investigate the encoding of individual variability, sex, sibling status (lambs), and litter size (ewes), developmental stage (age) in the vocal responses. The results demonstrate significant and detectable individual vocal signatures in both lambs and ewes across the examined stages and social isolation. Social isolation condition was strongly encoded in the vocalizations of lambs and ewes. Lamb vocalizations also encoded sibling status, whereas litter size was not encoded in the case of ewes' vocalizations. No evidence of sex-related encoding was found in lamb vocalizations, and

temporal information (postpartum day in ewes) was very weakly encoded. These results contribute to better understanding sheep communication and provide useful information for applications in precision livestock farming systems.

Diagnostic approach for early *Toxoplasma gondii* infection in pregnant sheep based on IgM serology

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Highlights

- Novel IgM-ELISA and IgM-WB were developed for early *T. gondii*-associated foetal death in sheep.
- IgM-ELISA was validated following WOAH standards with high precision.
- IgM-ELISA specificity concerns limit its use as a stand-alone assay.
- IgM marker is effective after excluding other abortifacient pathogens.
- A sequential IgM/IgG detection protocol for early foetal death is proposed.

Abstract

IgM detection is commonly employed for early diagnosis in human congenital toxoplasmosis. In small ruminants, accurate methods are needed to identify early foetal death (8–13 days post-infection), which often occurs without IgG seroconversion and parasite detection in the foetuses. The study aimed to develop and validate an ELISA based on lyophilized *Toxoplasma gondii* tachyzoites to detect anti-*T. gondii* IgM antibodies (IgM-ELISA) for sheep sera following WOAH guidelines. Using IgM-Western Blot (IgM-WB) as a reference test, sera panels comprising 735 sera from sheep experimentally- and naturally-infected with either *T. gondii* or other abortifacient pathogens were used. The IgM-TgSALUVET-ELISA demonstrated successful analytical validation, showing excellent precision (CV < 5%), good accuracy (R^2 = 0.85–0.96) and analytical sensitivity (detection limit: DO = 0.1). While IgM-WB showed no cross-reactivity between *T. gondii* antigens and anti-*Neospora caninum* and anti-*Chlamydia abortus* antibodies, IgM ELISA yielded false positives. IgM kinetics analyses in *T. gondii* experimentally-infected sheep enabled early diagnosis capability of IgM-ELISA and IgM-WB, detecting IgM immunoglobulins at 10 and 13 dpi, aligning with the early abortion timeframe. The IgM-ELISA achieved 84% diagnostic sensitivity, 83.9% specificity, AUC = 0.88, and substantial agreement with IgM-WB (*Kappa* = 0.61). Field investigations based on paired and sequential IgM/IgG comparisons suggest the IgM detection is useful as a marker of recent *T. gondii* infection after excluding other abortifacient pathogens. However, prolonged anti-*T. gondii* IgM persistence may complicate the interpretation of results. In sum, the IgM-ELISA test showed good performance under the conditions tested, although potential interferences limit its use as a stand-alone assay. Therefore, a sequential diagnostic approach in the event of suspected foetal death during early *T. gondii* infection in a flock is proposed.

Foraging for a fluke: Plant DNA metabarcoding reveals dietary signatures associated with liver fluke exposure in grazing lambs

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Highlights

- Faecal plant DNA profiles differed with recent *F. hepatica* exposure in lambs.
- *trnL* plant assemblages differed between *F. hepatica*-positive and negative lambs.
- *Ranunculus*/Ranunculaceae were associated with recent *F. hepatica* exposure.
- *F. hepatica*-negative lambs were associated with browse and field-margin taxa.
- Variation in grazing behaviour may help explain within-flock differences in *F. hepatica* exposure.

Abstract

Understanding within-flock variation in parasite exposure can underpin more targeted and sustainable control strategies. However, for *Fasciola hepatica*, the extent and drivers of such variation remain poorly understood, despite transmission requiring an intermediate host snail and therefore being inherently heterogeneous within grazing environments. This study investigated whether faecal plant DNA metabarcoding could identify dietary signatures associated with recent *F. hepatica* exposure in first-season grazing lambs. A total of 157 lambs from two commercial sheep farms in Wales, grazing land containing *G. truncatula* populations were screened using serum antibody ELISA, coproantigen ELISA and faecal egg counts. Nineteen lambs (12.1%) were seropositive, while coproantigen and pooled faecal egg counts were negative, consistent with recent exposure. Faecal samples from 17 seropositive and 19 seronegative lambs were analysed using complementary chloroplast *trnL* and *rbcL* metabarcoding markers via MinIon sequencing. Plant assemblage composition was strongly structured by farm, with *F. hepatica* status significantly associated with *trnL* community composition at both genus (R^2 = 0.059, p = 0.049) and family (R^2 = 0.073, p = 0.035) levels. Indicator taxon analysis identified *Lolium*, *Ranunculus* and *Trifolium* among taxa associated with *F. hepatica* positive lambs, whereas *Corylus*, *Carpinus* and *Mentha* were associated with *F. hepatica* negative lambs. These findings suggest that recent *F. hepatica* exposure is associated with distinct dietary signatures and that individual variation in forage and habitat use may contribute to heterogeneous exposure within flocks.

High body condition score of 3.5 – 4.0 in ewes at mating, scanning and in lactation is associated with long survival rates and high lifetime productivity: A seven-year prospective longitudinal study of 6000 ewes from eleven flocks in England

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Preventative Veterinary Medicine, Volume 257, December 2026 **OPEN ACCESS**

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Highlights

- Ewe BCS = 4.0 at mating, parturition and lactation maximises longevity of ewes, litter size and growth rate of lambs.
- There is a curvilinear association between BC and production with a plateau in improved productivity in ewes above BCS 4.0.
- Ewe lambs that gain 10 – 25% body weight when pregnant are more likely to produce a lamb than those that do not gain weight.
- Ewes first mated aged 6–7 months produce more lambs that grow faster over six years than ewes first mated when 18-19 months.

Abstract

Improving the lifetime productivity of ewes is important to improve efficiency and reduce greenhouse gas emissions from sheep farming. In 2017, eleven English sheep flocks with 6000 nulliparous ewe lambs or shearlings were enrolled into a seven-year prospective longitudinal study to investigate lifetime performance of ewes over six parities. Multivariable statistical models were used to investigate productivity and survival of ewes per year and over six-years of production. The key results were: lifetime performance of ewes was

dependent on their survival for all six parities; ewes mated as ewe lambs (6–7 months old) produced approximately one lamb more over their lifetime than ewes mated as shearlings (18–20 months old). Ewes that were body condition score ((BCS) (on a 1–5 point scale) 2.0 at parturition were four times as likely to die on farm as ewes with BCS > 2.0. Survival, litter size, lamb weight gain to eight-weeks and to weaning, increased as ewe body condition pre-mating, at parturition and in lactation increased from BCS 2.5 to BCS 3.5–4.75 (dependent on the outcome). For most measures of productivity production plateaued between BCS 4.0 and 4.75. This is the first study to provide a numeric estimate of when ewe productivity plateaus. This is the longest prospective study of ewe performance in England, and it highlights that maximum productivity occurs in sheep with a body condition score of 3.5 – 4.0, higher than previously hypothesised. The results can be used by the sheep industry together with input factors, such as farm location, sheep breed, nutrition and other costs, to optimise flock specific lifetime performance of ewes.

Repeated systemic β-NGF administration improves ejaculate characteristics in rams

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Highlights

- Systemic β-NGF increased the ejaculate volume and the total number of sperm per ejaculate.
- It enhanced the total motile, progressive motile, rapid, and normal sperm ejaculated.
- Testosterone concentrations did not change.
- Changes persisted for approximately 20 days after β-NGF administration.

Abstract

β-Nerve growth factor (β-NGF) influences reproductive function in several mammalian species, but the effects of repeated systemic administration on ram ejaculate traits are unknown. We evaluated the effects of four intramuscular administrations of 1 mg β-NGF purified from llama seminal plasma, given at 5-day intervals during the transition from the non-breeding to the breeding season, in adult Corriedale rams. Rams were assigned to a β-NGF-treated group or an untreated control group (n = 9/group). Semen was collected repeatedly from before treatment until Day 58, and evaluated scrotal circumference, serum testosterone, ejaculate traits, sperm motility, morphology, membrane functionality, and sperm kinematics were evaluated. β-NGF enhanced the temporal profiles of ejaculate volume and total sperm per ejaculate. Treated rams had a greater total number of sperm per ejaculate on 18, 30, and 37 days after beginning the treatment, and a greater ejaculate volume on day 37. Treatments did not affect the percentages of motile, morphologically normal, and HOST-positive sperm. Circulating testosterone concentrations and scrotal circumference were also unaffected. Thus, repeated systemic β-NGF administration transiently increased total sperm per ejaculate at specific post-treatment times without detectable changes in the evaluated indicators of sperm quality. The mechanisms underlying this response and its consequences for semen preservation and fertility remain to be determined.

Effects of pyrroloquinoline quinone (PQQ) on ram sperm quality and fertility potential during cooled storage

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Abstract
Ram spermatozoa are highly susceptible to cold-induced oxidative damage due to the abundance of polyunsaturated fatty acids (PUFAs) in their plasma membrane, which ultimately compromises fertilizing capacity. Adding antioxidants to semen extenders is a known strategy to protect sperm quality during cooling. This study evaluated the effects of different concentrations of pyrroloquinoline quinone (PQQ) in ram semen extender during chilled storage at 4°C. Semen samples were collected, diluted, and split into five groups: control (nothing added) and four groups with 10, 100, 1000, or 10000 nM PQQ. They were stored at 4°C for 48 h and checked for total motility (TM), progressive motility (PM), viability, membrane integrity (HOST), lipid peroxidation (MDA), and mitochondrial membrane potential (MMP) at 0, 24, and 48 h. In addition, fixed-time cervical artificial insemination (FTAI) was performed using semen stored for 24 h in 800 ewes. At 0 h, there were no differences among groups ($P > 0.05$). At 24 and 48 h, the PQQ100 group had higher TM, PM, viability, HOST, and MMP, and lower MDA than the other groups ($P \leq 0.05$). Pregnancy, parturition, and lambing rates were also better ($P \leq 0.05$) in the PQQ100 group (55.0%, 55.0%, and 57.0%) compared with the control group (29.0%, 27.5%, and 28.5%). Therefore, adding 100 nM PQQ to ram semen cooling extender appears to preserve sperm quality and fertility during storage at 4°C.

Supplementation of cryopreservation medium with pyrroloquinoline quinone improves post-thaw sperm quality in rams and fertility outcomes in ewes

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Abstract
Cryopreservation allows long-term storage and global distribution of high-genetic-merit ram sperm, but the freezing-thawing process damages sperm cells and lowers their fertilizing ability. This work assessed how different levels of pyrroloquinoline quinone (PQQ) supplementation affect frozen-thawed ram sperm characteristics and fertility results. Semen samples received 0, 10, 100, 1000, or 10,000 nM PQQ in the extender before standard freezing. Post-thaw evaluations measured sperm movement, membrane integrity, morphology, mitochondrial status, acrosome condition, cell survival, apoptosis markers, DNA damage, ROS levels, lipid peroxidation, and reproductive outcomes. Among all groups, 100 nM PQQ was most effective ($P \leq 0.05$), improving total motility (60.5%), progressive motility (40.2%), membrane functionality (61.5%), high mitochondrial membrane potential (65.7%), acrosome integrity (68.0%), and viability (51.5%), while reducing late apoptosis-like/membrane-damaged spermatozoa (38.0%), DNA fragmentation (9.5%), DCF-positive spermatozoa (20.1%), and lipid peroxidation (3.50 nmol/mL) compared with controls and other PQQ levels. Fertility testing also showed that 100 nM PQQ produced higher pregnancy (50%), parturition (48%), and lambing (50.5%) rates than the frozen-thawed untreated control (25%, 23.5%, and 24.5%, respectively). Thus, the optimal PQQ dose (100 nM) maintains post-thaw sperm quality and fertility, making it a valuable cryopreservation additive for sheep breeding.

Gut microbiota, metabolome and hormone profiles associate with pregnancy-related biomarkers in sheep with frozen embryo transfer

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Highlights

- Microbial succession (*Prevotellaceae* UCG-001, *Escherichia-Shigella*, *Lactobacillus*) linked to pregnancy outcome in ovine FET.
- Oleoyltaurine stage-persistent at transfer/diagnosis, inversely linked to *Escherichia-Shigella* and directly to *Lactobacillus*.
- Multi-omics linked LH/PGE2, cortisol/PGF2α to microbial/metabolomic data; oleoyltaurine as hub linking microbiota-metabolism.

Abstract

Recipients' gut microbiota and serum metabolites are linked to pregnancy outcomes in frozen embryo transfer (FET), but the underlying integrative mechanisms remain unclear. Here we compared the gut microbiome, serum metabolome, and reproductive hormones between pregnant (P group) and non-pregnant (N group) Small-Tailed Han ewes at three time points: prior to oestrus detection (1st), prior to embryo transfer (2nd), and prior to pregnancy diagnosis (3rd). Of 55 recipients, 24 became pregnant (43.6%). Beta-diversity of the gut microbiota partially separated P from N at 1st ($R^2 = 0.0597$, $P = 0.159$), 2nd ($R^2 = 0.0330$, $P = 0.293$), and 3rd ($R^2 = 0.0062$, $P = 0.405$). On the day of oestrus detection, *Prevotellaceae* UCG-001 was more abundant in the P group than in the N group ($P < 0.05$). On the day of embryo transfer, the opportunistic pathogen *Escherichia-Shigella* was enriched in the N group ($P < 0.05$). On the day of pregnancy diagnosis, the probiotic *Lactobacillus* was higher in the P group. Untargeted metabolomics identified 24, 24, and 33 stage-specific differential metabolites. Glycerophospholipid metabolism was consistently enriched across all stages. Notably, oleoyltaurine was a differential metabolite at both 2nd and 3rd (FC = 2.11 and 3.60, respectively; both $P < 0.05$). At oestrus, serum luteinizing hormone (LH) and prostaglandin E2 (PGE2) were significantly higher in the P group than in the N group ($P < 0.05$ for both). On the day of embryo transfer, cortisol and prostaglandin F2α (PGF2α) were markedly elevated in the N group ($P < 0.01$ for both). Microbiota-metabolite integration revealed that oleoyltaurine correlated negatively with *Escherichia-Shigella* ($r = -0.51$, $P < 0.05$) and positively with *Lactobacillus* ($r = 0.64$, $P < 0.05$). Adequate LH/PGE2 priming at oestrus was associated with a receptive peri-transfer period in ovine FET. This endocrine profile aligns with a distinct gut microbial succession and a systemic metabolomic signature, with oleoyltaurine emerging as a candidate metabolite putatively linking gut microbial shifts with systemic metabolic changes. These findings offer a basis for developing multi-target candidate biomarkers to improve recipient selection in sheep FET.

Thyroid hormone synthesis and AITD-related inflammatory factors are modulated during early pregnancy in ewes

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Highlights

- Pregnancy induces the expression of thyroid hormone synthesis-related factors, including TSHR, Tg, TPO, pendrin, and DUOX1.
- Pregnancy stimulates the expression of autoimmune thyroid disease-related inflammatory factors, including CTLA-4, IL-17A, and FOXP3.
- Pregnancy inhibits the expression of autoimmune thyroid disease-related inflammatory factors, including BAFF and IL-38.

Abstract

Pregnancy modulates the maternal thyroid to maintain endocrine and immune homeostasis. However, it remains unclear whether early pregnancy modulates thyroid hormone synthesis-related factors and autoimmune thyroid disease (AITD)-related inflammatory factors in the ovine thyroid. In this study, thyroid tissues were collected from ewes at day 16 of the estrous cycle (N16) and on days 13, 16, and 25 of pregnancy (G13, G16, and G25), and the mRNA and protein expression levels of these factors were examined by RT-qPCR, Western blot, and immunohistochemistry. The results showed that the expression of thyroid-stimulating hormone receptor increased gradually from N16 to G25, and thyroglobulin and thyroid peroxidase were significantly upregulated during pregnancy. In addition, sodium/iodide cotransporter mRNA and protein peaked at G16, and pendrin was elevated mainly at G13 and G16. However, dual oxidase 1 (DUOX1) was highest at G25, and DUOX2 peaked at G13. Furthermore, the expression of tyrosine-protein phosphatase non-receptor type 22 and tumor necrosis factor alpha peaked at G16, whereas B cell activating factor, retinoic acid receptor-related orphan receptor-γt, and interleukin (IL)-1α were reduced during pregnancy. Moreover, *IL-17A* mRNA and protein increased only at G25, and FOXP3 increased progressively from N16 to G25. In summary, early pregnancy modulates the expression of thyroid hormone synthesis-related factors and AITD-related inflammatory factors in a pregnancy stage-specific manner, which may be related to thyroid endocrine adaptation, immune homeostasis, and pregnancy establishment in ewes.

Upcoming events

Date	Event	Location
4 November 2025	MLP Classing and Selection AWI	Webinar
11 November 2026	MLP Overall outcomes AWI	Webinar