

AUGUST 2023

Sheep reproduction RD&A alert

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

The SRSP webinar series is returning in September. The **Let's talk rams** webinar will focus on the ram side of reproduction. Prof. Simon de Graaf (Sydney University) will provide an *overview of sexed semen and its role in sheep production systems* and Eloise Spanner, an Early Career researcher from Sydney University will present on *the prediction of successful ovine artificial insemination*. The SRSP webinar will be held on Thursday 29th September at 1.00 pm (AEST). Please click the following link to register for the [SRSP Let's talk rams webinar](#).

Program coordinator

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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.

Feature project update

Merino ewe mortality – prevalence, causes and mitigation strategies

Background

Reducing lamb and ewe mortality during lambing is a high priority for the sheep industry to address both animal welfare and productivity. This proposal builds on a recent study, which assessed rates and causes of periparturient ewe mortality across commercial maternal ewe flocks (L.LSM.0019) and will explore mortality in Merino ewes, which constitute over two-thirds of Australia's breeding ewe flock.

Aim

The project will examine Merino ewe mortality by starting with a literature review followed by an industry survey of on-farm losses and barriers to adopting best practice ewe management.

Project objectives

- Complete a literature review on annual Merino ewe mortality.
- Undertake an industry survey of Australian sheep producers to explore Merino ewe losses over a 12-month period, a description of possible cause of death and barriers to adopting practices aligned with reducing ewe mortality.
- Develop a farm lambing diary and post-moretum protocols to facilitate ewe mortality data collection.
- Complete producer case studies covering interventions to reduce Merino ewe mortality and the cost-benefit of these activities.
- Quantify the rates of periparturient Merino ewe mortality across the Australian sheep industry, identify key risk factors and potential intervention strategies and summarise the economic impacts of Merino ewe mortality and the value of intervention at a farm and industry level.

Current progress

The project has recently been contracted. For more information on the Merino ewe mortality project contact Joanna Jones (jjones@pinionadvisory.com).

Scientific papers

Embryo development and survival in peripubertal ewe lambs

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Animal Production Science, Volume 63 (issue 12), August 2023 **OPEN ACCESS**

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Abstract

Context: Mating of ewe lambs can increase farm profitability, although uptake is limited by low reproductive success. Reproductive loss to Day 35 of pregnancy in peripubertal ewe lambs is greater than in adult ewes; however, the precise timing of this loss is unknown.

Aim: We aimed to define more clearly early embryo development and key times of loss in peripubertal ewes.

Methods: Health and development of embryos from naturally cycling crossbred ewes ~8 months of age were recorded. Following mating across 2 years, ewes were assigned to three groups (n = 80–87 per group): assessed on Day 3 of pregnancy, on Day 14, or between Day 35 and birth. For Day 3 and Day 14 groups, ewes were humanely killed, and embryos were assessed by microscope following recovery from the reproductive tract. Ultrasonography at around Days 35 and 70, and lambing data, were used to assess loss in the third group.

Key results: By Day 3 of pregnancy, 22.9% of ova released were not present as healthy embryos ($P < 0.05$). Embryo survival on Day 14 tended ($P < 0.10$) to decrease further, with 34.0% ($\pm 4.5\%$) of ova released not present as healthy embryos. No decrease was detected between Days 14 and 35, whereas between Day 35 and birth, an additional 6.8% reproductive loss occurred ($P < 0.05$). Attainment of puberty prior to introduction of the fertile ram did not affect reproductive loss. Structures collected on Day 3 ranged from one cell to 12 cells: 11% (13/120) being one cell; 49% (59/120) two to four cells; and the remainder (48/120) at least five or six cells. Conceptus length at Day 14 ranged from 5.3 to 200.0 mm, with large variation between and within animals; within-ewe variation was 67% of between-ewe variation. Concentration of progesterone at time of collection was associated ($P < 0.001$) with developmental stage on Day 3, but not Day 14, of pregnancy.

Conclusions: Reproductive loss in peripubertal ewes primarily occurred prior to Day 14, with much of this loss before Day 3.

Implications: Improving oocyte and oviduct quality is important to supporting normal fertilisation and early embryo development in peripubertal ewe lambs, thus improving reproductive success.

Comparative evaluation of Duragen® and skim milk extenders to enhance ram semen quality and fertility: A promising alternative in ovine artificial insemination

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Reproduction in Domestic Animals, Volume 58 (Issue 8), August 2023

DOI <https://doi.org/10.1111/rda.14414>

Abstract

This study aimed to investigate the effectiveness of Duragen® and skimmed milk (SM) extenders on the quality parameters, bacterial load and fertilization ability of stored ram semen. A total of 50 ejaculates from Sardi rams (n = 5) aged 2.5–3 years, were collected and stored in Duragen® and SM at 15°C. The motilities and velocity parameters generated by the CASA system were then evaluated at 0, 8 and 24 h of storage. Afterward, bacterial loads of sperm extended in Duragen® and SM were determined at 0, 5 and 24 h of incubation. In addition, ewes (n = 100) aged 2 years, have been chosen in the same herd. The selected ewes were then synchronized and inseminated using semen extended in Duragen® and SM and stored for 5 h at 15°C. The results revealed that total and progressive motilities, straight velocity (VSL), straightness (SRT), lateral head displacement (ALH) and beat cross frequency (BCF) were not affected by the extender type after 24 h of storage ($p > .05$). However, curvilinear velocity (VCL), velocity average path (VAP), linearity (LIN) and wobble (WOB) showed higher values in Duragen® compared with SM extender after 24 h of storage ($p < .05$). Bacterial loads were observed mainly in sperm stored in SM at 5 h (183 UFC/mL) and at 24 h (357 UFC/mL) of incubation. However, the only case showing a bacterial load in Duragen® is when the storage time attains 24 h (199 UFC/mL). Concerning fertility, sperm diluted in both extenders resulting in high fertility rates which reaches 66% and 73% for Duragen® and SM, respectively, with no statistical difference ($p > .05$). In summary, Duragen® extender decreased bacterial load in stored semen and maintained high ram sperm quality and fertility. These findings suggest that Duragen® extender could be used as SM alternative in ovine artificial insemination (OAI).

The effect of by-pass linseed oil supplementation on the maternal antioxidant system during the embryo-maternal recognition period in ewes

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Simple Summary

The beneficial effect of polyunsaturated fatty acids (PUFA) in different body systems and their function in mammals is well known. The use of linseed oil (LO, rich in alpha-linolenic acid/ALA) as a feed additive has been investigated to improve the reproductive and productive performance of different livestock species. However, their effects on the antioxidative defense systems of female reproductive structures are scarcely documented. The results obtained in the present study demonstrate that dietary supplementation of by-pass LO enhances the antioxidative system in luteal and uterine tissues on maternal recognition of the pregnancy period (on Days 14 and 16 after mating) in ewes.

Abstract

This study analyzed the effects of dietary supplementation with by-pass linseed oil (LO; rich in α -linolenic acid) on maternal antioxidant systems at Days 14 and 16 of pregnancy in Sarda ewes. This trial used sixteen dry ewes. Eight ewes (CT group) were fed with a control diet without LO, and eight ewes (LO group) were fed with a diet supplemented with LO (10.8 g of α -linolenic acid/ewe/day). Both diets had similar crude protein and energy levels. The experiment included 10 days of an adaptation period and 31 days of a supplementation period. This supplementation period was divided into Period -2 (from Day -15 to -8), Period -1 (from Day -7 to -1; before synchronized mating period/Day 0), Period +1 (from Day +1 to +7 after mating), and Period +2 (from Day +8 to +15 after mating). Estrous synchronization was induced in all the ewes using an intravaginal sponge (45 mg fluorgestone acetate) for 14 days and equine chorionic

gonadotropin (350 UI/ewe) at the end of the treatment. On Days 14 (CT, N = 4; LO, N = 4) and 16 (CT, N = 4; LO, N = 4) after mating, the ewes were slaughtered. Samples of plasma, uterine, and luteal tissues were collected. Thiols, total antioxidant activity (TEAC), superoxide dismutase (SOD) activity, and malondialdehyde (MDA) content were measured. On Day 16, thiol and TEAC in luteal tissues were higher in the LO group when compared with the control one ($p < 0.05$). Moreover, TEAC was higher for the LO group in uterine tissues on Days 14 and 16 ($p < 0.05$). SOD activity was higher in the LO group in luteal and uterine tissues on Day 14 and Day 16, respectively ($p < 0.001$). On Day 16, uterine MDA content was lower for the LO group ($p < 0.001$). No differences were found between groups at the plasmatic level. However, the by-pass LO supplementation enhanced the analyzed antioxidant parameters in luteal and uterine tissues. In conclusion, these results demonstrate that by-pass LO supplementation exerted a positive effect on antioxidative defenses on maternal structures during the embryo-maternal recognition period in ewes. Thus, this could contribute to improving the maternal environment during the embryo-maternal recognition period in mammals.

Effect of reduced water intake on ovarian reserve, leptin immunoexpression and impact of leptin on the in vitro culture of sheep secondary follicles

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Animal Reproduction Science, Volume 255, August 2023

DOI <https://doi.org/10.1016/j.anireprosci.2023.107278>

Abstract

This study evaluated the effect of reduced water intake on survival, apoptosis and immunoexpression of leptin in sheep preantral follicles, activation of primordial follicles, serum levels of leptin, estradiol (E2) and progesterone (P4), and in vitro maturation (IVM) of oocytes antral follicles, as well evaluated the effects of leptin on in vitro culture of secondary follicles isolated these animals. Ewes ($n = 32$) were divided into four groups: water ad libitum (Control – 100%), 80%; 60% and 40% of ad libitum intake. Blood was collected to determine, leptin, E2 and P4, before and after experiment. After the slaughter, ovarian cortex was used to histological and immunohistochemistry analysis and oocytes IVM. Moreover, isolated secondary follicles were cultured in vitro for 12 days in control medium (α -MEM+) or α -MEM+ with 10 or 25 ng/mL leptin. The reduction of water intake caused a linear decreasing effect on the percentages of normal preantral follicles, especially of primordial ($P < 0.05$), increased the apoptosis ($P < 0.05$) and decreased leptin expression in preantral follicles. The treatment with 60% of water intake showed greater total growth rate of isolated secondary follicles cultured with 25 ng/L leptin ($P < 0.05$), compared to those cultured in α -MEM+. In conclusion, reduced water intake impaired the number of normal sheep preantral follicles, especially of primordial follicles, increased apoptosis and decreased leptin expression in preantral follicles. Moreover, secondary follicles from of ewes that receive 60% water intake increased follicular growth after in vitro culture with 25 ng/mL leptin.

Ovine fertility by artificial insemination in the breeding season could be affected by intraseasonal variations in ram sperm proteomic profile

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Highlights

- Fertility rate in Assaf breed is lower at the beginning of the breeding season.
- Ram reproductive parameters are similar during the whole mating season.
- Ram sperm proteomic profile changes through the breeding season.
- Ram sperm proteins could be used as fertility biomarkers.

Abstract

It is important to note that seasonality could affect ram reproductive parameters, and therefore, fertility results after artificial insemination. In this work, 1) we assessed fertility rates after cervical artificial insemination of 11,805 ewes at the beginning (June 21st to July 20th) and at the end (November 20th to December 21st) of the reproductive season in the Assaf breed for the last four years, and 2) we aimed to identify male factors influencing the different reproductive success obtained depending on the time at the mating season in which ovine artificial insemination was performed. For this purpose, we evaluated certain ram reproductive and ultrasonographical parameters as well as we performed a multiparametric and proteomic sperm analysis of 6–19 rams at two very distant points in the mating season (July as Early Breeding Season –EBS– and November as Late Breeding Season –LBS–). Rutinary assessments carried out in the ovine reproduction centers (testicular volume, libido, sperm production and mass motility) showed non-significant differences ($P \geq 0.05$) between both studied times, as well as the ram ultrasonographic evaluation (Resistive and Pulsatility Index as Doppler parameters; and pixels mean gray level, and hypoechoic areas percentage and density as echotexture parameters). However, at level of sperm functionality, although sperm quality appeared non-significantly lower ($P \geq 0.05$) in the EBS, we identified a significantly different ($P < 0.05$) sperm proteomic profile between the seasonality points. The following proteins were identified with the lowest abundance in the EBS with a fold change > 4 , a $P = 2.40e-07$, and a $q = 2.23e-06$: Fibrous Sheath-Interacting Protein 2, Disintegrin and Metalloproteinase Domain-Containing Protein 20-like, Phosphoinositide-Specific Phospholipase C, Tektin 5, Armadillo Repeat-Containing Protein 12 Isoform X3, Solute Carrier Family 9B1, Radial Spoke Head Protein 3 Homolog, Pro-Interleukin-16, NADH Dehydrogenase [Ubiquinone] 1 Alpha Subcomplex Subunit 8, Testis, Prostate and Placenta-Expressed Protein, and Acyl Carrier Protein Mitochondrial. In conclusion, while our basic analyses on male and sperm quality showed similar results between the beginning and the end of the breeding season, on a proteomic level we detected a lower expression of sperm proteins linked to the energy metabolism, sperm-oocyte interactions, and flagellum structure in the EBS. Probably, this different protein expression could be related to the lower fertility rate of Assaf ewes after cervical artificial insemination at this time. More importantly, sperm proteins can be used as highly effective molecular markers in predicting sperm fertilization ability related to intraseasonal variations.

Metformin improves sheep sperm cryopreservation via vitalizing the AMPK pathway

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Theriogenology, Volume 208, 15 September 2023

DOI <https://doi.org/10.1016/j.theriogenology.2023.05.031>

Abstract

Adenosine 5'-monophosphate (AMP)-activated protein kinase (AMPK) is a key regulator of sperm function and physiological metabolism. Metformin, an inexpensive and effective antioxidant, is known to play an

important role in the activation of AMPK. Therefore metformin has potential to improve sperm cryopreservation. The aim of this study was to investigate the effect of metformin during semen cryopreservation of sheep and to find the most effective concentration in freezing extender. Semen were cryopreserved with extender containing different concentrations of metformin (0, 0.25, 0.5, 1.0, 2.0 and 4.0 mmol/L). Sperm motility, acrosome integrity and plasma membrane integrity were measured after semen freezing and thawing. All results showed that sperm quality was significantly increased in the 1.0 mmol/L metformin-treated group compared with the control group ($P < 0.05$). In addition, the study showed that metformin effectively reduced the content of malondialdehyde (MDA) and reactive oxygen species (ROS), and increased the activity of glutathione peroxidase (GSH-Px), superoxide dismutase (SOD), catalase (CAT) and total antioxidant capacity (T-AOC) of freeze-thawed sperm ($P < 0.05$). The optimal concentration of metformin was 1.0 mmol/L. Moreover, the results showed that AMPK was localized in the acrosome region, junction and midsection of sperm, and p-AMPK was distributed in the post-acrosomal region, junction and midsection. Western blot analysis indicated that 1.0 mmol/L metformin stimulated the phosphorylation of AMPK in sperm. Further results showed that 1.0 mmol/L metformin significantly increased the mitochondrial membrane potential ($\Delta\Psi_m$), ATP content, glucose uptake and lactate efflux of post-thawed sperm through the AMPK pathway, improved sperm quality, and increased the cleavage rate of in vitro fertilization ($P < 0.05$).

The mitochondria-targeted antioxidant “MitoQ” preserves quality and reproductive performance of ram spermatozoa cryopreserved in soybean lecithin-based extender

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Abstract

Cryopreservation of ram semen is helpful for distributing proved spermatozoa for reproductive goals, but cold shock has destructive effects on fertility ability of frozen sperm cells. This study was performed to investigate the effect of the novel mitochondria-targeted antioxidant “MitoQ” on ram sperm quality and fertility potential during cryopreservation process. Semen samples were diluted in extenders supplemented with 0, 1, 10, 100 and 1000 nM MitoQ and then frozen according to the standard protocol. Motility and velocity characteristics, lipid peroxidation, acrosome integrity, membrane functionality, mitochondria active potential, viability, apoptosis status, DNA fragmentation, ROS concentration and reproductive performance were evaluated after thawing. In results, 10 and 100 nM MitoQ presented higher ($P \leq 0.05$) total motility, progressive motility, average path velocity, acrosome integrity, membrane functionality, mitochondria active potential and viability as well as lower ($P \leq 0.05$) lipid peroxidation, apoptosis status, DNA fragmentation and ROS concentration compared to the control group and the other treatments. Moreover, after fertility trial, 10 and 100 nM MitoQ resulted in higher ($P \leq 0.05$) pregnancy, parturition and lambing rates than control group. Therefore, MitoQ is able to preserve quality parameters and fertility potential of post-thawed spermatozoa in sheep and it could be an effective additive for supplementation of ram's semen cryopreservation medium during reproductive programs.

Refinements in embryo manipulation applied to CRISPR technology in livestock

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Abstract

The implementation of CRISPR technology in large animals requires further improvements in embryo manipulation and transfer to be applied with commercial purposes. In this study we report (a) developmental competence of CRISPR/Cas microinjected zygotes subjected to in vitro culture in large scale programs in sheep; (b) pregnancy outcomes after early-stage (2–8-cell) embryo transfer into the oviduct or the uterine horn; and (c) embryo survival and birth rate after vitrification/warming of CRISPR/Cas microinjected zygotes. Experiment 1 consisted of a retrospective analysis to evaluate embryo developmental rate of in vitro produced zygotes subjected to CRISPR/Cas microinjection (n = 7,819) compared with a subset of non-microinjected zygotes (n = 701). Development rates to blastocyst on Day 6 were 20.0% for microinjected zygotes and 44.9% for non-injected zygotes (P < 0.05). In Experiment 2, CRISPR/Cas microinjected zygotes were transferred on Day 2 after in vitro fertilization (2-8 cell embryos) into the oviductal ampulla (n = 262) or into the uterine horn (n = 276) in synchronized recipient ewes at prefixed time (i.e., approximately two days after ovulation). Pregnant/transferred recipients (24.0% vs. 25.0%), embryo survival/transferred embryos (6.9% vs. 6.2%), and born lambs/pregnant embryos (72.2% vs. 100.0%) did not differ significantly in the two groups. In Experiment 3, CRISPR/Cas microinjected zygotes were maintained under in vitro culture until blastocyst stage (Day 6), and subjected to vitrification/warming via the Cryotop method (n = 474), while a subset of embryos were left fresh as control group (n = 75). Embryos were transferred into the uterine horn of recipient females at prefixed time 8.5 days after the estrous synchronization treatment (i.e., approximately six days after ovulation). Pregnancy rate (30.8% vs. 48.0%), embryo survival rate (14.8% vs. 21.3%), and birth rate (85.7% vs. 75.0%) were not different (Pdouble bondNS) between vitrified and fresh embryos, respectively. In conclusion, the current study in sheep embryos reports (a) suitable developmental rate after CRISPR/Cas microinjection (i.e., 20%), even though it was lower than non-microinjected zygotes; (b) similar outcomes when Day 2-embryos were placed into the uterine horn instead of the oviduct, avoiding both time-consuming and invasive oviduct manipulation, and extended in vitro culture during one week; (c) promising pregnancy and birth rates obtained with vitrification of CRISPR/Cas microinjected embryos. This knowledge on in vitro embryo development, timing of embryo transfer, and cryopreservation of CRISPR/Cas microinjected zygotes have practical implications for the implementation of genome editing technology in large animals.

Defining optimal thresholds for digital Brix refractometry to determine IgG concentration in ewe colostrum and lamb serum in Scottish lowland sheep flocks

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Preventive Veterinary Medicine, Volume 219, September 2023 **OPEN ACCESS**

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Highlights

- Advised Brix thresholds for ewe colostrum are: poor < 22%; fair 22–26% and good > 26%.
- Advised Brix thresholds for lamb serum are: poor < 8%; fair 8–9% and good > 9%.
- Ewe colostrum IgG concentration was positively associated with that of lamb serum.

Abstract

This research aimed to define thresholds for ewe colostrum and lamb serum Brix refractometer measurements in lowland Scottish sheep. This would facilitate the use of this convenient, sheep-side test, enabling quick and accurate identification of poor quality colostrum and prevention of failure of transfer of passive immunity (FTPI) in lambs. Secondary aims were to identify risk factors for poor colostrum quality and FTPI in lambs. Serum samples (n = 233) were collected from lambs between 24 and 48hrs after birth, from four lowland Scottish meat sheep farms. Pre-suckle colostrum samples (n = 112) were also collected from

ewes on two of these farms. Farmers provided information on litter size, ewe body condition score, ewe breed and dystocia. Duplicate digital Brix refractometer measurements were compared with immunoglobulin G (IgG) radial immunodiffusion (RID) testing for all colostrum and serum samples. Receiver operating characteristic (ROC) curves were used to redefine thresholds for Brix testing in colostrum and serum. Linear regression models were constructed with colostrum and serum IgG concentration as the outcomes of interest. Colostrum and serum IgG concentrations were highly variable. The prevalence of inadequate colostrum quality (using <50 g/L IgG on RID) was 4.5% (95% CI = 1.5 – 10.1) and the prevalence of FTPI (using <15 g/L IgG in serum on RID) was 7.73% (95% CI = 4.64–11.93). A ewe's colostrum IgG concentration was significantly and positively associated with the serum IgG concentration of her lamb(s) ($p = 0.02$). ROC analysis defined a Brix threshold for adequate colostrum quality of > 22.10% (sensitivity 80% (95%CI=28.4–99.5), specificity 90% (95%CI=82.3–94.8)). ROC analysis defined a Brix threshold for serum of > 8.65% for adequate passive transfer of immunity in Scottish lambs (sensitivity 94% (95%CI=72.7–99.8), specificity 82% (95%CI=76.6–87.2)). To optimise passive transfer of immunity in lambs, we suggest that ewe colostrum Brix measurements be defined as 'poor' (<22%); 'fair' (22–26%) and 'good' (>26%); and lamb serum as 'poor' (<8%); 'fair' (8–9%) and 'good' (>9%). It is recommended that these tests are used as for flock screening, using samples from multiple animals.

The extent of placental pathology is negatively correlated to birth weight in ewes infected with the wild-type strain of *Chlamydia abortus*

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Small Ruminant Research, Volume 226 September 2023 **OPEN ACCESS**

DOI <https://doi.org/10.1016/j.smallrumres.2023.107029>

Highlights

- Ovine enzootic abortion (OEA) infections cause economic losses in ovine flocks.
- Aborted fetuses and weak lambs are the cause of production losses in OEA.
- Lambs born to affected ewes are weaker and more susceptible to disease.
- The degree of the placental lesions is associated with the gestation length and, consequently, with foetal viability.
- First report of relationship between the placental lesion and disease outcome.

Abstract

The placenta is the organ that allows the exchange of oxygen and nutrients between maternal and foetal blood, supplying the requirements of the growing foetus. Consequently, any factor that alters placental integrity may affect foetal nutrition, viability and lamb birth weight. Reproductive diseases, such as ovine enzootic abortion (OEA), impact on foetal viability due to the reduction in the functional area for maternofetal exchange. This study aimed to consider the impact of pathological features of OEA placental lesions on lamb birth weight and indirectly on foetal viability. To investigate the relationship between birth weight and various OEA-related parameters, data from 562 lambs/foetuses from animals experimentally challenged with *Chlamydia abortus* strain S26/3 and from uninfected animals were analysed. The parameters investigated included the number of foetuses/lambs delivered (single/multiple), foetus/lamb sex, length of gestation, the proportion of placentas affected by lesions (percentage of gross placental pathology), foetal viability (live/aborted) and the number of *C. abortus* organisms shed in post-parturition vaginal excretions. The results suggest that the length of gestation and the proportion of placentas affected by lesions are the main contributors to birth weight variability, whereas the other factors, including foetal viability (live or aborted outcomes), were found to be less relevant co-variables. The study determined the strongest positive

and negative correlations between birth weight were with the length of gestation and the extent of placental pathology, respectively. These results may indicate that economic losses associated with OEA infections result not only from aborted fetuses but also from the surviving lambs that are born weaker and consequently are more susceptible to diseases.

Nutrient restriction during pregnancy and litter size affect the feeding behaviour, feed preference and welfare of the aged ewe's offspring

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Highlights

- Aged ewes born to nutrient restricted mothers preferred to eat first the fatty than the protein feed.
- Aged ewes born to nutrient restricted mother showed moderate hyperphagia.
- Aged twin ewes born to nutrient restricted mothers spent more time eating and less time lying than their singleton peers.
- Aged twin ewes ate less than singletons, regardless the mother nutritional treatment.

Abstract

The present work evaluates the effect of a nutrient maternal restriction induced by a lower forage allowance of natural grassland (LFA) and the type of birth [single (S) and twins (T)] and its interaction on the feed preference, the feeding behaviour, and welfare indicators of aged offspring ewes. A total of 28 Corriedale, seven years old, multiparous ewes in the anestrus period (spring) were used: 11 singles (S) and 4 twins (T) born to high forage allowance mothers (HFA: 10 – 12 DM/100 kg LW·day), and 9 S and 4 T born to LFA (5 – 8 DM/100 kg LW·day) from 23 days before conception to 122–123 days of gestation. The ewes were subjected to a feeding behaviour trial during 5 days after and adaption period of 14 days to eat alfalfa hay ad libitum and 300 g of rice bran. Eight days before the registration began animals were transferred to a roofed barn and located in individual pens with separated alfalfa and rice bran feeders, and a free-available water source. The feed preference was registered twice a day. Dry matter intake (DMI) was daily determined. Behaviour of each ewe was recorded every 10 min from 0800 to 1200 h, and from 1400 to 1800 h. The percentage of ewes that preferred to rice eat bran first was greater in LFA than HFA ewes (73% vs. 45%; $P = 0.04$). The alfalfa hay intake was greater in LFA than in HFA ewes (3078 vs. 2949 ± 0.61 g/day; $P = 0.04$) and in S than in T ewes (3126 vs. 2932 ± 61.0 g/day, $P < 0.01$). All ewes ate the total offered amount of rice bran (300 g/d each), thus DMI showed the same response that alfalfa intake previously described. The % of time eating alfalfa hay was greater for LFA than HFA (38.0 vs 29.2 ± 3.4 ; $P < 0.01$). These variables were not influenced by the interaction. The time spent eating and standing up, and time spent resting were affected by the interaction treatment \times TB ($P \leq 0.05$ in all cases) as T-LFA ewes spent more time eating ($P = 0.02$) and thus, standing up ($P = 0.02$), but less resting ($P = 0.02$) and with no apparent activity ($P = 0.05$) than T-HFA with no differences between LFA and HFA groups in the S ewes. In conclusion the maternal nutrient restriction affected the preference for feed, the ingestive behaviour and the welfare of aged female offspring.

Timing and duration of nutrient restriction and its impacts on placental development and umbilical blood flow in adolescent sheep

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Abstract

We hypothesized that nutrient restriction from day 50–90 of gestation decreases umbilical blood flow and that umbilical blood flow would recover to control values upon realimentation during late gestation (d 90 to 130) or remain reduced in ewes that continued to be nutrient restricted. On d 50 of gestation, young nulliparous whiteface ewes (6–8 mo; n = 41) carrying singletons were randomly assigned to two dietary treatments: 100% of NRC recommendations (CON) or 60% of CON (RES). On d 90 of gestation, ewes either remained on CON or RES until d 130, or CON ewes were RES from d 90 to 130, or RES ewes were realimented to CON from d 90 to 130. This resulted in 4 treatment groups on day 130: CON–CON, CON-RES, RES-RES, RES-CON. Umbilical blood flow and fetal and placental measurements were obtained via ultrasonography every 10 days from day 50–110. Non-survival surgeries were performed on days 50, 90, and 130 (n = 6–7 ewes/group) where uterine artery and umbilical blood flows were measured during surgery via ultrasonography. Conceptus weights were recorded and placentomes collected to determine binucleate cell numbers. The study was conducted as a completely randomized design arrangement with repeated measures. Data were analyzed using the MIXED procedure of SAS. There was a nutritional treatment by day interaction ($P < 0.01$) with CON ewes having greater umbilical blood flow compared with RES by d 90. Fetal biparietal distance, abdominal width, and kidney area increased ($P < 0.05$) in CON-RES with all these measurements increasing during late gestation. We partially accept our hypothesis as nutrient restriction during mid gestation decreased umbilical blood flow. However, blood flow did not return to control levels upon realimentation. By d 130, fetal and placental weights were similar between RES-RES and CON–CON. Binucleate cell numbers in the fetal trophoblast were not influenced by nutritional treatments. Our findings suggest that refeeding previously nutrient restricted pregnant adolescent ewes to control levels does not reestablish umbilical blood flow. Adequate placental development during mid gestation could protect the fetus from a decreased umbilical blood flow later in gestation when nutrients were limited by 40%.

Upcoming events

Date	Event	Location
29 September 2023	Let's talk rams Sheep Reproduction Strategic Partnership (SRSP)	Webinar