SEVEN
publicações acadêmicas

EFFECT OF THE LUNAR PERIOD ON SHEEP REPRODUCTION

EFEITO DO PERÍODO LUNAR NA REPRODUÇÃO DE OVINOS

EFECTO DEL PERÍODO LUNAR EN LA REPRODUCCIÓN DE OVEJAS

https://doi.org/10.56238/sevened2025.034-006

José Evânio da Costa Siebra[1], Tatiana Gouveia Pinto Costa[2], Davi Nogueira Maciel Alves[3], Ednaldo Barbosa Pereira Junior[4], Hugo Vieira[5], Francisco de Sales Oliveira Filho[6]

ABSTRACT

The study aimed to evaluate the reproductive performance of sheep according to the lunar phases. Twenty crossbred Dorper females, 20 crossbred Santa Inês females aged between 2 and 4 years, and two two-year-old PO male Dorper and Santa Inês males were used. The study was conducted at the Sheep Production Education Unit of the Animal Science Department of the Federal Institute of Paraíba, Sousa-PB Campus (IFPB), and lasted three and a half years. Controlled breeding procedures were used, where the males were confined in their own stalls, and each female in estrus, identified by the bullfighter in a semi-intensive grazing system, was led and placed with the male for a period of 12 hours. The breeding animals were kept in stables according to the breeder's breed criteria, with no breeding season or estrus stimulation through hormones. There was also no crossbreeding (mating between breeds). Data collection was performed according to the lunar phases established by the Brazilian National Observatory (ONB), which corresponded to the lunar phase with maximum thirst up to two days before and two days after the date of interest. The variables studied were offspring sex (SP), gestation length (TG), and birth weight (BW). Statistical analysis used to evaluate the proportion of male and female births related to the lunar phase used Fisher's exact test at a 5% probability level. Analysis of variance was used to assess the effects of lunar phase, type of delivery, and breed on birth weight and gestation length, with post-hoc Tukey's test at a 5% probability level of significance. R software (R Core Team; 2023) was used for all analyses. Laboratory analyses were performed at the Animal Parasitology Laboratory of the Department of Veterinary Medicine of the Federal Institute of Paraíba (IFPB). Based on the results obtained, it was possible to determine that the waning moon phase influences the reproductive process of sheep.

[1] Veterinary Doctor. Departamento de Produção, Pesquisa e Extensão (IFPB).
E-mail: jose.siebra@ifpb.edu.br Orcid: https://orcid.org/0009-0000-6012-4978
Lattes: https://lattes.cnpq.br/6038744603263220
[2] Professor. Coordenação de Agropecuária do (IFPB). E-mail: tatiana.costa@ifpb.edu.br
Orcid: https://orcid.org/0000-0002-3888-4994 Lattes: https://lattes.cnpq.br/1387592615606263
[3] Professor. Departamento de Produção, Pesquisa e Extensão (IFPB).
E-mail: davi.nogueira@ifpb.edu.br Orcid: https://orcid.org/0009-0001-3770-8518
Lattes: https://lattes.cnpq.br/7155880497442297
[4] Professor. Departamento de Agroecologia (IFPB). E-mail: Ednaldo.pereira@ifpb.edu.br
Orcid: https://orcid.org/0000-0003-0098-3206 Lattes: https://lattes.cnpq.br/3705874601912500
[5] Professor. Departamento de Agroecologia (IFPB). E-mail: hugo.vieira@ifpb.edu.br
Orcid: https://orcid.org/0000-0002-9583-8409 Lattes: https://lattes.cnpq.br/2662802573719840
[6] Agroecology Technologist. Departamento de Produção, Pesquisa e Extensão (IFPB).
E-mail: ddpe.ss@ifpb.edu.br Orcid: https:// orcid.org/0000-0002-4276-862X
Lattes: https:// lattes.cnpq.br/1805177889138569

Keywords: Moon Phases. Crossbred Sheep. Offspring Sex. Paraíba Backlands. Sheep Reproduction.

RESUMO

O estudo teve como objetivo avaliar o desempenho reprodutivo de ovinos em função das fases da lua. Foram utilizadas 20 fêmeas mestiças de Raça Dorper, 20 fêmeas mestiças de Raça Santa Inês com idade entre 02 e 04 anos e 02 reprodutores PO com 02 anos de idade das Raças Dorper e Raça Santa Inês. O estudo foi conduzido na Unidade Educativa de Produção de Ovinocultura do Departamento de Zootecnia do Instituto Federal da Paraíba, Campus Sousa-PB (IFPB) com duração de três anos e meio. Foram utilizadas montas controladas onde os reprodutores ficaram confinados em baias próprias e cada fêmea em cio identificada pelo rufião em sistema de pastejo semi-intensivo, era conduzida e colocada junto ao reprodutor por um período de 12 horas, obedecendo o critério racial dos reprodutores e não sendo obedecida período de estação de monta ou estimulação de cio através de hormônios; como também não houve cruzamento (acasalamento entre raças). A coleta dos dados foi obtida segundo as fases lunares vigentes pelo Observatório Nacional Brasileiro (ONB), sendo consideradas correspondentes à fase lunar onde a sede máxima foi até dois dias antes e dois dias depois da data de interesse. As variáveis estudadas foram sexo da prole (SP), tempo de gestação (TG) e peso ao nascer (PN). A Análise estatística utilizada para avaliar a proporção de nascimentos de machos e fêmeas relacionadas com a fase da lua, foi empregado o Teste Exato de Fisher a nível de 5% de probabilidade. Para avaliar os efeitos da fase da lua, tipo de parto e raça sobre peso ao nascer e duração da gestação foi empregado análise de variância, com post-hoc Tukey com nível de significância de 5% de probabilidade. Para todas as análises foi empregado o software R (R Core Team; 2023). As análises laboratoriais foram realizadas no Laboratório de Parasitologia Animal do Departamento de Medicina Veterinária do Instituto Federal da Paraíba (IFPB). A partir dos resultados obtidos foi possível determinar que a fase da lua minguante apresenta influência no processo reprodutivo de ovinos.

Palavras-chave: Fases da Lua. Ovinos Mestiços. Sexo da Prole. Sertão da Paraíba. Reprodução de Ovinos.

RESUMEN

El estudio tuvo como objetivo evaluar el rendimiento reproductivo de ovejas según las fases lunares. Se utilizaron veinte hembras mestizas Dorper, veinte hembras mestizas Santa Inês, de entre 2 y 4 años, y dos machos PO Dorper y Santa Inês de dos años. El estudio se llevó a cabo en la Unidad de Enseñanza de Producción Ovina del Departamento de Zootecnia del Instituto Federal de Paraíba, Campus Sousa-PB (IFPB), y tuvo una duración de tres años y medio. Se utilizaron procedimientos de monta controlada, donde los machos fueron confinados en sus propios establos, y cada hembra en celo, identificada por el torero en un sistema de pastoreo semi-intensivo, fue conducida y colocada junto al macho durante 12 horas. Los animales reproductores se mantuvieron en establos según los criterios raciales del criador, sin época de monta ni estimulación del celo mediante hormonas. Tampoco se realizaron cruces entre razas. La recolección de datos se realizó según las fases lunares establecidas por el Observatorio Nacional de Brasil (ONB), que corresponden a la fase lunar con máxima sed hasta dos días antes y dos días después de la fecha de interés. Las variables estudiadas fueron sexo de la cría (SP), duración de la gestación (TG) y peso al nacer (PN). El análisis estadístico utilizado para evaluar la proporción de nacimientos de machos y hembras en relación con la fase lunar utilizó la prueba exacta de Fisher con un

nivel de probabilidad del 5%. Se utilizó un análisis de varianza para evaluar los efectos de la fase lunar, el tipo de parto y la raza sobre el peso al nacer y la duración de la gestación, con la prueba post-hoc de Tukey con un nivel de probabilidad de significancia del 5%. Se utilizó el software R (R Core Team; 2023) para todos los análisis. Los análisis de laboratorio se realizaron en el Laboratorio de Parasitología Animal del Departamento de Medicina Veterinaria del Instituto Federal de Paraíba (IFPB). Con base en los resultados obtenidos, fue posible determinar que la fase de luna menguante influye en el proceso reproductivo de las ovejas.

Palabras clave: Fases Lunares. Ovejas Mestizas. Sexo de las Crías. Sertión de Paraíba. Reproducción de Ovejas.

1 INTRODUCTION

The Moon is the Earth's natural satellite and its participation in various aspects of society has been described for many years. In this regard, there is a popular belief that states that this star has a direct influence on the reproductive cycle of several species.

The influence of the lunar cycle on large bodies of water, plants, and animals has been observed for a long time, determining the tidal cycle and affecting the physiology of aquatic and terrestrial plants and animals (Jovchelevich, 2006). Scientific information is scarce on the influence of the lunar cycle on animal biology. However, there are reports of this influence on invertebrates, fish, birds, and wild mammals (Julien-Laferriere, 1997; Jovchelevich, 2006), as well as in men (Cajochen et al., 2013).

The influence of the moon on animal reproduction is a frequent target of speculation, especially about the time and type of calving, with contradictory studies and no physiological explanations in this regard in the human species (Bueno et al., 2010). The equine species is also the target of these speculations, without support in the scientific literature.

The effects of the moon on the male:female ratio of the offspring is associated with popular sayings (Bueno et al., 2010), but without support in the scientific literature (Cameron, 2004; Aurich and Schneider, 2014). The factors that affect the male:female ratio in mammals can be expressed at conception, favoring the fertilization of oocytes by spermatozoa that carry the X or Y chromosomes (Martin, 1997; Silva et al., 2008

The effects of the moon on the moment of childbirth are also associated with popular sayings (Bueno et al., 2010), but with scientific evidence when a higher incidence of full moon births in humans was observed (Stern et al., 1988; Arliss et al., 2005).

The information about the moon's interference on horse reproduction transcends generations, causing rural producers to use it empirically and place their trust in the choice of the gender of the products according to the phase used at the time of covering the mares (SOUSA, 2017). In different cultures, the moon is related to fertility, pregnancy and childbirth (BUENO, 2010). For many centuries myths and strategies have been developed with the aim of selecting the desired sex. However, there is no evidence to support these methods (SCOTT et al., 2018).

The lunar phases accompany human beings from birth and are very important for agriculture and the raising of domestic animals (RIVERA, 2005).

Nowadays there are still remnants of peasant wisdom in the use of the phases of the moon in agriculture, forestry and animal management. Popular knowledge often associates

the moon with the success or failure of sowing, grafting, harvesting, slaughtering, hoofing, deworming, avoiding dangers in castration or interventions for the cure and treatment of some diseases that affect cattle (RIVERA, 2005). There are few studies that have evaluated the influence of lunar rhythms on horses. (FERRIOLA, et al. (2019) found a significant association between the moon phase and colic days in horses, with the highest frequencies occurring during the crescent phase and the full moon. Although the action of the moon on the tidal cycle, the physiology of plants (pressure and depression of the sap), aquatic and terrestrial animals has already been verified, its influence on animal reproduction has not yet been sufficiently clarified (RIVERA, 2005).

To this day, rural producers place their trust in the choice of the gender of the products according to the phase of the moon used at the time of covering the mares (SOUSA, 2017). It is believed that when fertilization is achieved on a waning moon towards the new moon, the female sex predominates and when it is reached on a crescent moon towards the full moon, the male sex predominates (RIVERA, 2005).

AGUILAR et al. (2014) analyzed the mating dates in different phases or lunar days (full/new moon cycle and perigee/apogee cycle) of thoroughbred and Arabian horses registered in the Argentine Stud Book (between 2003 and 2011) and the sex ratio at birth, but the percentages of males and females at birth were not different.

2 MATERIAL AND METHODS

The study was conducted at the Educational Unit for Sheep Production of the Federal Institute of Paraíba (IFPB), Campus de Sousa-PB, located at 220 m altitude, 6º 45' 33" south latitude and 38º 13' 41" west longitude, with an average annual temperature of 27ºC and 58% relative humidity, in the upper hinterland region of Paraíba, 430 km from the capital João Pessoa, from October 2016 to June 2020.

A total of 42 (forty-two) sheep animals were used in the study, 20 (twenty) crossbred Santa Inês breeders, 20 (twenty) Dorper crossbred breeders with an initial age between 2 and 3 years old and 02 (two) PO sires of the Santa Inês and Dorper breeds with 02 years of age without any degree of kinship. The project was not submitted for evaluation to the Ethics Committee (CEUA) of the Federal Institute of Paraíba Campus de Sousa-PB, but we are aware of the content of Normative Resolution No. 31 of August 18, 2016 and Normative Resolution No. 32 of September 6, 2016 of the National Council for the Control of Animal Experimentation – CONCEA. Before the beginning of the study, all animals underwent a

rigorous clinical examination and were submitted to blood count, parasitological feces and individual deworming tests. Laboratory analyses were carried out at the Animal Parasitology Laboratory of the Department of Veterinary Medicine of the Federal Institute of Paraíba (IFPB), Sousa-PB Campus.

The sows remained in the semi-intensive grazing system with the permanent presence of the ruffian and in the afternoon, when they returned to the sheepfold for the night, they received a food supplementation based on sorghum silage and mineralized salt. The breeders remained all the time confined in their own stalls, receiving water and bulky and concentrated food 02 (two) times a day in feeders and drinkers installed in the stalls, sheltered from the sun or rain, disinfected, hygienic and comfortable in order to meet all the requirements of animal welfare.

When the female's heat was observed, always detected by the ruffian, this sow was led by the keeper to the stall of the breeder of the corresponding breed, remaining together for 12 (twelve) hours so that there were at least 02 (two) mounts. For the realization of the controlled mounting, the breeder criterion of the sire was obeyed and no breeding season period or any type of hormonal stimulation of the females' heat was observed, as well as there was no crossing (mating between breeds). The data collection of the variables studied were obtained according to the lunar phases in force by the Brazilian National Observatory (ONB), being considered to correspond to the lunar phase where the maximum thirst was up to two days before and two days after the date of interest. The variables studied were offspring sex (SP), gestation time (TG) and birth weight (BW).

The statistical analysis used to evaluate the proportion of male and female births related to the moon phase, the Fisher's Exact Test was used at the level of 5% probability. To evaluate the effects of moon phase, type of delivery and race on birth weight and gestation length, analysis of variance was used, with post-hoc Tukey with a significance level of 5% probability. For all analyses, the R (R Core Team; 2023.

3 RESULTS AND DISCUSSION

The influence of moon phases on sheep reproduction is not a scientific consensus, but some popular practices and beliefs suggest a correlation. Some studies with sheep have found no significant influence of the lunar phase on the incidence of calving or the sex ratio at birth.

The effects of the moon on the male:female ratio of the offspring is associated with popular sayings (Bueno et al., 2010), but without support in the scientific literature (Cameron, 2004; Aurich and Schneider, 2014). The factors that affect the male:female ratio in mammals can be expressed at conception, favoring the fertilization of oocytes by spermatozoa that carry the X or Y chromosomes (Martin, 1997; /silva et al.; 2008).

Although this study does not propose to present mechanisms involved in the lunar action on the reproductive aspects of the sheep studied, it was possible to identify at least one effect of the lunar cycle on the reproduction of the Dorper and Santa Inês breeds.

The statistical analysis (table 1), through Fisher's Exact Test at the level of 5% probability when done in general, presents a significant effect for the number of male offspring conceived in the full moon period, however, when separating the breeds it only has a significant effect for the Santa Inês breed during the waning moon when more females are born.

3.1 PROPORTION OF MALES AND FEMALES IN RELATION TO THE PHASE OF THE MOON.

In total, 26 females (13 Dorper and 13 Santa Inês) and 31 males (13 Dorper and 18 Santa Ines) were born, there was no significant difference between the proportions.

Table 1

Effect of the moon phase on the birth of males and females

Race	Gender	Flood	Crescent	Waning	Nova	Total	p* value
General	Female	3	6	11	6	26	p= 0.028
	Male	9	12	3	7	31	
Dorper	Female	3	2	4	4	13	p= 0.521
	Male	4	4	1	4	13	
Saint Agnes	Female	0	4	7	2	13	p= 0.035
	Male	5	8	2	3	18	

* Probability value related to Fisher's Exact Test.
Source: The authors.

The statistical data (tables 2, 3 and 4), through analysis of variance with post-hoc Tukey at the level of 5% probability, did not have a significant effect on the weight of the offspring at birth and in the gestation period.

3.2 BIRTH WEIGHT AND LENGTH OF GESTATION

Table 2

Summary of the analysis of variance for birth weight and gestation length in Dorper and Santa Inês sheep

Source of Variation	Birth Weight	Length of Gestation
Moon Phase	Ns	Ns
Race	*	Ns
Type of Delivery	**	Ns
Sex of the Offspring	Ns	*

Source: The authors.

Table 3. Average Birth Weight as a function of race and type of delivery

Source of Variation	Average ± Standard Error	
Race	Dorper	Saint Agnes
	3.12a ± 0.07	2.84b ± 0.07
Type of Delivery	Simple	Double
	3.22a ± 0.09	2.43b ± 0.06

Source: The authors.

Table 3

Average gestation duration as a function of the sex of the offspring

Source of Variation	Average ± Standard Error	
Sex of the Offspring	Female	Male
	150.30a ± 0.30	149.48a ± 0.28

Source: The authors.

4 FINAL CONSIDERATIONS

From the results obtained in the study it was possible to determine that the full moon in general had a significant effect on the birth of males, however, when the breeds are separated, it only has a significant influence on the reproductive process of sheep on the waning moon, originating a greater number of females, especially in the Santa Inês breed. There was no significant effect on birth weight and gestation time of both breeds.

Despite our findings, we believe that the superstition between the moon and the number of males, females, calving and gestation time in sheep reproduction will continue to exist.

REFERENCES

Aguilar, J. J., Cuervo-Arango, J., & Santa Juliana, L. (2014). Lunar cycles at mating do not influence sex ratio at birth in horses. Chronobiology International, 31(1-5), 1–5. https://doi.org/10.3109/07420528.2014.978960

Arliss, J. M., Kaplan, E. N., & Galvin, S. L. (2005). The effect of the lunar cycle on frequency of births and birth complications. American Journal of Obstetrics and Gynecology, 192(5), 1462–1464. https://doi.org/10.1016/j.ajog.2004.12.034

Bastos, A. M., Lima, J. F., & Dias, M. T. (2017). A influência do ciclo lunar na reprodução e tempo incubação de ovos (Macrobrachium amazonicum) e manejo sustentável da biodiversidade amapaense. In Conhecimento de Macrobrachium amazonicum e manejo sustentável da biodiversidade amapaense (pp. 145–159). São Paulo, Brazil: Blucher.

Bermejo-Alvarez, P., Rizos, D., Rath, D., Lonergan, P., & Gutierrez-Adan, A. (2011). Transcriptional sexual dimorphism during preimplantation embryo development and its consequences for developmental competence and adult health and disease. Reproduction, 141(5), 563–570. https://doi.org/10.1530/REP-10-0482

Bueno, A., Iessi, I. L., & Damasceno, D. C. (2010). Influência do ciclo lunar no parto: Mito ou constatação científica? Revista Brasileira de Enfermagem, 63(3), 477–479. https://doi.org/10.1590/S0034-71672010000300022

Cajochen, C., Altanay-Ekici, S. I., Münch, M., Frey, S., Knoblauch, V., & Wirz-Justice, A. (2013). Evidence that the lunar cycle influences human sleep. Current Biology, 23(15), 1485–1488. https://doi.org/10.1016/j.cub.2013.06.029

Cameron, E. Z. (2004). Facultative adjustment of mammalian sex ratios in support of the Trivers-Willard hypothesis: Evidence for a mechanism. Proceedings of the Royal Society of London B: Biological Sciences, 271(1549), 1723–1728. https://doi.org/10.1098/rspb.2004.2773

Castex, H. R., & Losinno, L. (2018). Magnetic nanoparticles for x sperm separation from equine semen: Field and commercial results. In Memorias del IX Seminario Internacional de Medicina, Cirugía, Ortopedia y Reproducción Equina (p. 268). Medicina Veterinaria y Zootecnia.

Christensen, B. W. (2011). Parturition. In A. O. McKinnon, E. L. Squires, W. E. Vaala, & D. D. Varner (Eds.), Equine reproduction (2nd ed., Vol. 2, pp. 2268–2276). Ames, IA: Wiley-Blackwell.

Eulálio, N. C., Borges, L. M., Lopes, E. P., Gomes, P. S., & Valle, G. R. (2013). Taxas de perda gestacional até 60 dias são afetadas por características cíclicas da égua receptora de embrião Mangalarga Marchador. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 65(2), 397–403. https://doi.org/10.1590/S0102-09352013000200015

Ferriola, D., Vigouroux, L., Bryk-Lucy, J., & Ritchie, L. (2019). Meteorological and lunar influence on the occurrence of colic in horses. Journal of Equine Veterinary Science, 76, 128. https://doi.org/10.1016/j.jevs.2019.03.206

Franke, R., & Horstgen-Schwark, G. (2013). Lunar-rhythmic molting in laboratory populations of the noble crayfish Astacus astacus (Crustacea, Astacidea): An experimental analysis. PLoS ONE, 8(7), e68626. https://doi.org/10.1371/journal.pone.0068626

Gibbs, W., Lye, S. J., & Challis, J. R. G. (2006). Parturition. In J. D. Neill (Ed.), Knobil and Neill's physiology of reproduction (3rd ed., Vol. 2, pp. 2925–2974). St. Louis, MO: Elsevier Academic Press.

Jovchelevich, P. (2006). Revisão de literatura sobre a influência dos ritmos astronômicos na agricultura. Revista Núcleo de Pesquisa Interdisciplinar. http://www.fmr.edu.br/npi/014.pdf

Julien-Laferriere, D. (1997). The influence of moonlight on activity of woolly opossums (Caluromys philander). Journal of Mammalogy, 78(1), 251–255. https://doi.org/10.2307/1382659

Marinho, E. N., França, F. C., Santos, G. S., Barbosa, D. H. F., Silva Filho, J. M., Palhares, M. S., Lopes, E. P., Viana, W. S., Esquarcio, L. M. G. S., & Valle, G. R. (2015). O ciclo lunar influencia diferentemente o momento do parto de éguas de acordo com o sexo do potro. Revista Brasileira de Reprodução Animal, 39(2), 296–300.

Marteniuk, J. V., Carleton, C. L., Lloyd, J. W., & Shea, M. E. (1998). Association of sex of fetus, sire, month of conception, or year of foaling with duration of gestation in Standardbred mares. Journal of the American Veterinary Medical Association, 212(11), 1743–1745.

Martin, J. F. (1997). Length of the follicular phase, time of insemination, coital rate and the sex of offspring. Human Reproduction, 12(3), 611–616. https://doi.org/10.1093/humrep/12.3.611

Mattana, J., Pimenta, C. L., & Blainski, J. M. L. (2018). Artigo sobre o calendário biodinâmico: As fases e posições da lua. Maneje Bem- Especial, 1, 5–22. https://www.manejebem.com.br/publicacao/manejos/livro-digital-artigo-sobre-ocalendario-biodinamico-como-funciona

McCue, P. M., & Ferris, R. A. (2011). Parturition, dystocia and foal survival: A retrospective study of 1047 births. Equine Veterinary Journal, 44(Suppl. 41), 22–25. https://doi.org/10.1111/j.2042-3306.2011.00476.x

McCue, P. M., Scoggin, C. F., & Lindholm, A. R. G. (2011). Estrus. In A. O. McKinnon, E. L. Squires, W. E. Vaala, & D. D. Varner (Eds.), Equine reproduction (2nd ed., Vol. 2, pp. 1716–1727). Ames, IA: Wiley-Blackwell.

Morrison, D. W. (1978). Foraging ecology and energetics of the frugivorous bat Artibeus jamaicensis. Ecology, 59(4), 716–723. https://doi.org/10.2307/1938775

Newcombe, J. R., & Nout, Y. S. (1998). Apparent effect of management on the hour of parturition in mares. Veterinary Record, 142(9), 221–222. https://doi.org/10.1136/vr.142.9.221

Nicolich, M. J., Huebner, W. W., & Schnatter, A. R. (2000). Influence of parental and biological factors on the male birth fraction in the United States: An analysis of birth certificate data

from 1964 through 1988. Fertility and Sterility, 73(3), 487–492. https://doi.org/10.1016/S0015-0282(99)00576-2

Oliveira Filho, K. S., & Saraiva, M. V. O. (2013). Astronomia e astrofísica. Porto Alegre, Brazil: Universidade Federal do Rio Grande do Sul, Departamento de Astronomia.

Orvos, H., Kozinsky, Z., & Bartfai, G. (2001). Natural variation in the human sex ratio. Human Reproduction, 16(4), 803. https://doi.org/10.1093/humrep/16.4.803

Ousey, J. C. (2011). Endocrinological adaptation. In A. O. McKinnon, E. L. Squires, W. E. Vaala, & D. D. Varner (Eds.), Equine reproduction (2nd ed., Vol. 2). Ames, IA: Wiley-Blackwell.

Portugal, S. J., Branco, C. R., Frappell, P. B., Verde, J. A., & Butler, P. J. (2019). Impacts of “supermoon” events on the physiology of a wild bird. Ecology and Evolution, 9(14), 7974–7984. https://doi.org/10.1002/ece3.5311

Raeside, J. I., & Liptrap, R. M. (1975). Patterns of urinary estrogen excretion in individual pregnancy mares. Journal of Reproduction and Fertility, Supplement, 23, 469–475.

Rivera, J. R. (2005). La Luna: El Sol Nocturno en los trópicos y su influencia en la agricultura (2nd ed.). Bogotá, Colombia: Impresora Feriva.

R Core Team. (2023). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/

Samper, J. C., Morris, L., Peña, F. J., & Plough, T. A. (2012). Commercial breeding with sexed stallion semen: Reality or fiction? Journal of Equine Veterinary Science, 32(8), 471–474. https://doi.org/10.1016/j.jevs.2012.06.018

Scott, C., Souza, F. F., Mothé, G. B., Aristizabal, V. H. V., & Del’Aqua Junior, J. D. (2018). Estudo sobre as diferentes técnicas de sexagem de espermatozoides. Veterinária e Zootecnia, 25(1), 021–029.

Schneider, J. (2014). Sex determination in horses – Current status and future perspectives. Animal Reproduction Science, 146(1-2), 34–41. https://doi.org/10.1016/j.anireprosci.2014.01.014

Silva, A. E. F., Dias, M. J., Dias, D. S. O., Duarte, J. B., & Andrade, J. R. A. (2008). Influência do momento da inseminação artificial sobre a fertilidade e o sexo da cria de novilhas da raça Nelore. Ciência Animal Brasileira, 9(4), 997–1003.

Singaravelan, N., & Marimuthu, G. (2002). Moonlight inhibits and lunar eclipse enhances foraging activity of fruit bats in an orchard. Current Science, 82(8), 1020–1022.

Sousa, Y. C., Leite, E. V., Santos, A. S., Malafaia, G., & Alves Júnior, J. R. F. (2017). Influência lunar sobre a determinação sexual de potros quarto de milha. In Anais VI Congresso Estadual de Iniciação Científica e Tecnológica do IF Goiano. Urutaí, Brazil: IF Goiano.

Stern, E. W., Glazer, G. L., & Sanduleak, N. (1988). Influence of the full and new moon on onset of labor and spontaneous rupture of membranes. Journal of Nurse-Midwifery, 33(2), 57–61. https://doi.org/10.1016/0091-2182(88)90152-3

Valle, G. R., Silva Filho, J. M., Henry, M. R. J. M., Palhares, M. S., & Oliveira, H. N. (1998). Efeitos da rufiação e da manipulação do sistema genital sobre a fertilidade de éguas inseminadas. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 50(5), 547–556. https://doi.org/10.1590/S0102-09351998000500015

Wolf, A., & Gabaldi, S. H. (2002). Acompanhamento ultrassonográfico da gestação em grandes animais. Ciência Agrária e Saúde, 2(1), 77–83.