

Influence of breeding experience on the sexual behavior of Criollo stallions during semen collection with an estrous mare

Fernanda Carlini Cunha dos Santos^{1*}  Carlos Eduardo Wayne Nogueira²  Bruna da Rosa Curcio² 

¹Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), 38610-000, Unai, MG, Brasil. E-mail: carlini.fernanda@hotmail.com.

*Corresponding author.

²Universidade Federal de Pelotas (UFPeL), Pelotas, RS, Brasil.

ABSTRACT: Stallion sexual behavior is modulated by factors such as the seasonality, handling, age, and sexual experience, and the behavioral patterns observed during semen collection differ from those during natural mating. This study characterized the sexual behavior of Criollo stallions during semen collection and compared the precopulatory and copulatory behavior responses between inexperienced and experienced. Fifty-five stallions were evaluated including reaction time, mount time, mount to ejaculation time, mounts without erection or ejaculation, Flehmen's response, sniffing, biting, kicking, and vocalizations. The animals were classified as inexperienced (≤ 4 years, $n=14$) or experienced (5–16 years, $n=41$). Subsequently, experienced were also subdivided by age (5–8, 9–12, and 13–16 years). Statistical analyses included the Wilcoxon test, Kruskal-Wallis, analysis of variance, and Tukey's test ($P < 0.05$). Inexperienced stallions exhibited significantly longer reaction (47.5 ± 31.9 s) and mount times (85.8 ± 56.3 s) than experienced (21 ± 8.1 s and 34.3 ± 11.6 s, respectively), whereas mount to ejaculation duration (~ 35 s) did not differ between groups. Subdivision of experienced showed that reaction and mount time significantly decreased with age, whereas mount to ejaculation interval were similar across three age groups. The most consistent precopulatory behaviors were vocalization and sniffing, regardless of sexual experience. Inexperienced stallions tended to require multiple mounts more often to achieve ejaculation. In conclusion, breeding experience influenced the behavioral patterns of Criollo stallions during semen collection with an estrous mare, resulting in shorter collection times in experienced stallions. Criollo stallions exhibited typical precopulatory and copulatory behaviors.

Key words: behavioral assessment, copulatory, precopulatory, reproductive behavior, sexual arousal, sexual maturity.

Influência da experiência reprodutiva no comportamento sexual de garanhões Crioulos durante a coleta de sêmen com égua em cio

RESUMO: O comportamento sexual de garanhões é modulado por fatores como sazonalidade, manejo, idade e experiência sexual, sendo que padrões comportamentais observados durante a coleta de sêmen diferem daqueles durante a monta natural. Este estudo caracterizou o comportamento sexual de garanhões Crioulos durante a coleta de sêmen e comparou as respostas comportamentais pré-copulatórias e copulatórias entre inexperientes e experientes. Cinquenta e cinco garanhões foram avaliados quanto ao tempo de reação, tempo de monta, tempo entre monta e ejaculação, montas sem ereção ou ejaculação, resposta Flehmen, cheirar, mordidas, coices e vocalizações. Os animais foram classificados em inexperientes (≤ 4 anos, $n=14$) ou experientes (5–16 anos, $n=41$). Posteriormente, os experientes também foram subdivididos por faixa etária (5–8, 9–12 e 13–16 anos). As análises estatísticas incluíram os testes de Wilcoxon, Kruskal-Wallis, análise de variância e Tukey ($P < 0,05$). Os garanhões inexperientes apresentaram tempo de reação ($47,5 \pm 31,9$ s) e de monta ($85,8 \pm 56,3$ s) significativamente maiores do que os experientes ($21 \pm 8,1$ s e $34,3 \pm 11,6$ s, respectivamente), enquanto a duração da monta até a ejaculação (~ 35 s) não diferiu entre os grupos. A subdivisão dos garanhões experientes mostrou que o tempo de reação e de monta diminuíram significativamente com a idade, enquanto o intervalo da monta até a ejaculação foi semelhante entre as três faixas etárias. Os comportamentos pré-copulatórios mais consistentes foram vocalização e cheirar, independentemente da experiência sexual. Garanhões inexperientes tenderam a necessitar de múltiplas montas com maior frequência até atingir a ejaculação. Em conclusão, a experiência reprodutiva influenciou os padrões comportamentais dos garanhões Crioulos durante a coleta de sêmen com égua em estro, resultando em tempo de coleta mais curto nos experientes. Os garanhões Crioulo exibiram comportamentos pré-copulatórios e copulatórios típicos.

Palavras-chave: avaliação comportamental, copulatória, pré-copulatória, comportamento reprodutivo, excitação sexual, maturidade sexual.

INTRODUCTION

The Criollo horse is a traditional equine breed in South America, with characteristics and breeding programs varying across countries such as Brazil, Uruguay, Argentina, Paraguay, and Chile. In Brazil, Criollo horses have been selectively bred for

traits of sports competitions, endurance, morphologic features and adaptability to the Southern Pampas climate. Esteemed for its athletic capabilities, this breed occupies a central role in traditional equestrian competitions and has been recognized as an element of cultural heritage. According to Brazilian Association of Criollo Horse Breeders (ABCCC, 2025), the

national population of Criollo horses exceeds 508,000 individuals and continues to increase annually.

As the demand for genetically superior animals intensifies, reproductive biotechnologies, such as semen cryopreservation and artificial insemination, have become central to equine breeding programs. However, the success of these biotechnologies depends on the physiological quality of semen and on the stallion's sexual behavior during semen collection. Sexual behavior is shaped by multiple factors including environmental conditions, photoperiod, seasonality, the nature of the stimulus (dummy vs. estrous mare), prior training and handling, age, and sexual experience (CANISSO et al., 2010; MCDONNELL, 1992; NAJJAR et al., 2010). Moreover, stallions exhibit distinct sexual behavior during semen collection compared to natural mating (NOUE et al., 2001).

Despite the growing use of Criollo stallions in reproductive programs, a notable lack of breed-specific studies describing their sexual behavior during semen collection is observed. Understanding the behavioral aspects that may affect semen collection efficiency is important for optimizing collection protocols, enhancing safety procedures and improving reproductive performance. Therefore, this study aimed to characterize the sexual behavior of Criollo stallions during on-farm semen collection using an artificial vagina and restrained estrous mares during the breeding season. Specific objectives included: (1) describing the behavioral patterns exhibited during semen collection and (2) comparing the behavior of inexperienced and experienced stallions during precopulatory and copulatory interactions.

MATERIALS AND METHODS

Animals

This study was conducted using 55 Criollo breed stallions, in Rio Grande do Sul, Brazil. Stallions from three reproductive centers were included in the study, and all were maintained under similar reproductive management conditions. Animals were housed under an intensive management system in standard individual stalls and fed a diet consisting of commercial pelleted feed and alfalfa hay. For semen collection, stallions were led and handled by experienced personnel in a designated collection area, followed by an immediate return to the stall. All animals had the official ABCCC brand on their right hind limb, indicating compliance with the standard body measurements and morphological traits of the breed, thus qualifying them for breeding.

Semen collection and sexual behavior

Semen collection was conducted on-farm at the onset of one breeding season (spring), using a restrained estrous mare and a Botucatu-model artificial vagina, with the assistance of experienced handlers and three veterinarians specialized in equine reproduction. All collections were video recorded for subsequent behavioral analysis, which was performed by one single trained person. The following variables were evaluated to characterize the sexual behavior of each stallion:

Reaction time: interval from the presentation of the mare to the stallion until penile exposure;

Mount time: time elapsed from mare presentation to initiation of copulation;

Mount and ejaculation time: duration from the onset of mounting to ejaculation and dismounting;

Mounts without erection: instances where the stallion mounted with a flaccid penis;

Mounts without ejaculation: cases in which the penis was inserted into the artificial vagina without ejaculation;

Flehmen response, sniffing, biting, kicking, and vocalization.

Each stallion was submitted for semen collection once and categorized based on reproductive experience: Inexperienced: up to 4 years old and serving as breeders for the first time in their life ($n=14$); Experienced: aged 5 to 16 years, with at least one prior breeding season ($n=41$). Experienced stallions were maintained under sexual rest since the end of the previous breeding season.

Subsequently, experienced stallions ($n=41$) were also subdivided into three age categories: 5–8 years ($n=12$), 9–12 years ($n=15$), and 13–16 years ($n=14$), to further investigate potential age-related effects in this category.

Statistical analysis

Descriptive statistics were applied to the time-based variables (reaction, mount, and mount to ejaculation time) and expressed as mean $\pm$ standard error of the mean, in seconds (s). Data normality was assessed before analysis, and comparisons between groups were performed using the Wilcoxon test, Kruskal-Wallis, analysis of variance, and Tukey's test ($P<0.05$). Frequency distributions (%) were calculated for categorical variables, including mounts without erection, mounts without ejaculation, Flehmen's response, sniffing, biting, kicking, and vocalization. Statistical analyses were conducted using Statistix 9® software (Statistix, Tallahassee, FL, USA, 2008).

RESULTS AND DISCUSSION

Stallions exhibited an immediate interest upon visual contact with restrained mares. Under the guidance of a handler using a halter and long lead rope, each stallion was directed to approach the mare from the posterior region to initiate precopulatory interactions. Upon full erection, the stallion was permitted and encouraged to mount the mare using the rear approach. After successful mounting, the penis was manually lateralized by manipulating the prepuce and was gently guided into the artificial vagina by the veterinarian. Ejaculation was achieved after a series of pelvic thrusts within an artificial vagina. The stallion then relaxed and dismounted and subsequently returned to its individual stall. Regarding the sexual behavior of Criollo stallions during on-farm semen collection, the cyclic behavioral patterns observed in the present study were consistent with those described by MCDONNELL (1992) in other horse breeds.

Inexperienced Criollo stallions had significantly longer reaction time and mount time than experienced, while mount to ejaculation duration was similar between groups (Table 1). Overall, semen collection from inexperienced stallions required more time owing to delayed behavioral responses.

Regarding reaction time, inexperienced Criollo stallions required significantly more time (47.5 ± 31.9 s) compared to experienced (21 ± 8.1 s). In Nordestina stallions, mean reaction time was 25.4 s, with significant age-related differences – older stallions exhibited shorter reaction times (16 s) than younger stallions (30 s) (RIBEIRO et al., 2025). Conversely, in Mangalarga Marchador, RUA et al. (2015) reported no significant difference between young (17.9 ± 21.6 s)

and adult (11.4 ± 12.6 s). Mean reaction time reported for other breeds include 89 ± 11 s in French stallions (NOUE et al., 2001), 95.4 s in Arab stallions (WAHEED et al., 2015), $69\text{--}99$ s in Lusitano stallions (ROBALO SILVA et al., 2007), 56.2 ± 92.9 s in Brazilian Ponies (RUA et al., 2016), and 78.1 ± 64.6 s in Pantaneiro stallions (RUA et al., 2020).

According to MCDONNELL (2009), domesticated stallions typically achieve erection within two minutes of visual contact with an estrous mare. However, untrained stallions often require more time to expose the penis, likely because of their unfamiliarity with the context and uncertainty about the expected behavior. In addition to age and sexual experience, factors such as stallion management (eg: use of restraint) and collection environment (eg: confined shed versus open pen) may influence reaction time (IONATA et al., 1991).

Experienced Criollo stallions exhibited a mean mount time of 34.3 ± 11.6 s, whereas inexperienced stallions required significantly more time (85.8 ± 56.3 s). VERONESI et al. (2010) reported an average mounting time of 27.8 ± 10 in light horse. RUA et al. (2015) found mean of 32.6 ± 3.5 s, with no significant difference between age groups of young (28.1 ± 21) and adults (38.7 ± 24.3 s) in Mangalarga Marchador. Our findings suggested that stallions submitted to regular collection appeared to become habituated, which contributed to reduced mounting latency.

Precopulatory interactions in natural mating may span hours or even days; however, the actual copulatory phase, from approach to ejaculation, often lasts for less than 60 s (MCDONNELL, 1992). Mount to ejaculation time of Criollo stallions was similar between inexperienced (34.8 ± 5.3 s) and experienced (35.8 ± 3.5 s), indicating that, unlike reaction and mount time, the duration from mounting to ejaculation is not significantly influenced by prior sexual experience.

RUA et al. (2015) reported similar mount to ejaculation time in young (24.5 ± 7 s) and adult (24.2 ± 4.8 s) in Mangalarga Marchador. In contrast, Nordestina stallions showed a mean mount to ejaculation interval of 62.05 s (RIBEIRO et al., 2025), while Pantaneiro exhibited a considerably longer mean duration encompassing mounting, ejaculation, and dismounting (199.4 ± 166.5 s) (RUA et al., 2020). Both Brazilian breeds, Nordestina and Pantaneiro, were not used to controlled breeding management and human handling interference (RIBEIRO et al., 2025; RUA et al., 2020), which may account for the longer copulatory times.

Table 1 - Mean $\pm$ standard error of the mean of sexual behavior parameters of inexperienced and experienced Criollo stallions during on-farm semen collection using a restraint estrus mare and artificial vaginal (n=55).

	Inexperienced (n=14)	Experienced (n=41)
Reaction time	47.5 ± 31.9^a	21 ± 8.1^b
Mount time	85.8 ± 56.3^a	34.3 ± 11.6^b
Mount and ejaculation time	34.8 ± 5.3^a	35.8 ± 3.5^a

*Parameters expressed in seconds.

^{a,b} Indicates significant difference between inexperienced and experienced stallions.

Analysis of the three subdivisions of experienced Criollo stallions revealed that reaction time and mount time significantly and progressively decreased with age, with significantly shorter values in aged 13-16 years (10.5 ± 1.9 and 18.9 ± 3.8 s, respectively) and 9-12 (10 ± 1.4 and 22.9 ± 2.7 s, respectively) compared to those aged 5-8 years (27.5 ± 5.9 and 48.3 ± 13 s, respectively). In contrast, mount to ejaculation time remained consistent (34-36) across age groups (Table 2). This pattern suggested that, even among sexually mature stallions, experience may shorten the precopulatory phase, resulting in a faster initiation of copulatory behavior without affecting the duration of ejaculation once mounting occurs.

Precopulatory behaviors of Criollo stallions are summarized in table 3. In accordance with hand-breeding standards, mounts without erection were not permitted, to prevent repeated unsuccessful attempts, minimize injury risk, and reduce total breeding time. While no mounts occurred without erection, 50% of inexperienced and 34% of experienced stallions required multiple mounts (one to three) before ejaculation.

Among free-running or pasture-bred, mounts without erection are a typical component of the precopulatory sequence (MCDONNELL, 2000), a behavior documented in both novice and experienced equid species (FREITAS et al., 2006; HENRY et al., 1991; MCDONNELL, 1992; MCDONNELL, 2000). In ponies, the average number of mounts without ejaculation (2.1 ± 3.5) occurred more frequently than without erection (0.8 ± 1.3) (RUAS et al., 2016). HOUSSOU et al. (2020) reported mean values of two mounts per ejaculation in Arabian and 1.46 in Barb stallions. Older Nordestina stallions typically followed a more direct copulatory sequence — sniffing the vulva, vocalizing, exposing the penis, and mounting — with fewer mounts without erection

(RIBEIRO et al., 2025). RUA et al. (2015) reported that even when allowed, Mangalarga Marchador stallions (4.5% young and 9.1% adults) rarely mounted without erection.

Allowing stallions to mount without erection can function as sexual stimulation, by permitting this natural behavior may enhance arousal and stimulate faster copulation (MCDONNELL, 2000). Sexual experience, number of mounts, and collection duration influence semen characteristics. False mounts can increase ejaculate volume and seminal plasma content; although, excessive stimulation may reduce sperm concentration and motility (SAHIN et al., 2020). Behavioral and handling conditions during semen collection can affect seminal volume and total sperm count (BURGER et al., 2015). Overall, these emphasize the need for appropriate behavioral management to optimize semen quality and collection efficiency.

Precopulatory interactive behaviors in stallions that are allowed to mate freely in the field typically include vocalizations, sniffing, nuzzling, biting, nipping, kicking, and Flehmen response (MCDONNELL, 1992). Only a few experienced Criollo stallions (12.2%) displayed Flehmen response, while none of the inexperienced stallions did. Flehmen's response is not predominant courtship behavior, but may play a more specific role in detecting pheromonal cues related to the mare's estrous state (STAHLBAUM & HOUP, 1989). Younger Nordestina stallions exhibited more sniffing and Flehmen's responses, whereas older males vocalized more frequently (RIBEIRO et al., 2025).

Air-kicking behavior was observed only in experienced Criollo stallions (12.2%), all with prior aggressive histories. While recognized as a natural precopulatory response (MCDONNELL, 1992), kicking is strongly discouraged during semen collection due to the safety risks. Biting was more

Table 2 - Mean $\pm$ standard error of the mean of sexual behavior parameters of experienced Criollo stallions ($n = 41$), subcategorized by age interval (years-old), during on-farm semen collection using a restraint estrus mare and artificial vaginal.

	5-8y (n=12)	9-12y (n=15)	13-16y (n=14)
Reaction time	27.5 ± 5.9^a	10 ± 1.4^b	10.5 ± 1.9^b
Mount time	48.3 ± 13^a	22.9 ± 2.7^b	18.9 ± 3.8^b
Mount and ejaculation time	36.4 ± 1.8^a	36.1 ± 1.2^a	34.6 ± 1.6^a

*Parameters expressed in seconds.

^{a,b}Indicates significant difference between age interval.

Table 3 - Frequency distribution (%) of sexual behavior of Criollo stallions during on-farm semen collection using a restraint estrus mare and artificial vagina (n=55).

	Inexperienced (n=14)	Experienced (n=41)
Sniffing	100	70.7
Vocalizations	100	95.1
Flehmen response	0	12.2
Biting	64.3	19.5
Kicking	0	12.2
Mount without erection	0	0
One mount without ejaculation	35.7	19.5
Two mounts without ejaculation	14.2	12.2
Three mounts without ejaculation	0	2.4

common in inexperienced than in experienced Criollo stallions. Regardless of prior sexual experience, vocalization and sniffing emerged as the most consistently expressed precopulatory behaviors.

Based on the behavioral observations of our study, practical applications can be proposed to enhance stallion training programs and improve the efficiency, safety, and welfare of semen collection and reproductive management. Allowing controlled precopulatory behaviors, such as brief teasing or non-ejaculatory mounting under supervision, may help support natural arousal patterns, particularly in inexperienced stallions. The incorporation of mock collection sessions, combined with positive reinforcement, can gradually accustom young stallions to handling, mare exposure, and mounting without the immediate expectation of ejaculation. Providing adequate space, employing experienced handlers, and maintaining a consistent collection routine can contribute to greater safety and confidence during procedures, thereby reducing behavioral variability and associated risks. Regardless of breed, age, or prior sexual experience, each stallion exhibits individual behavioral traits that must be recognized and considered when designing training and management plans.

CONCLUSION

Breeding experience influenced the behavioral patterns of Criollo stallions during semen collection with estrous mares, resulting in shorter collection times in experienced stallions. Sexual behavioral patterns observed in Criollo stallions during semen collection were consistent with those described in other horse breeds and were characterized by the expression of typical precopulatory and copulatory behaviors.

ACKNOWLEDGMENTS

The authors thank Universidade Federal de Pelotas and Universidade Federal dos Vales do Jequitinhonha e Mucuri for support.

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUITIONS

All authors contributed equally to the manuscript.

BIOETHICS AND BIOSECURITY COMMITTEE APPROVAL

This animal experimentation was approved by the Institutional Research Ethics Committee of the Universidade Federal de Pelotas (UFPe), under protocol number 9893-2014.

DATA AVAILABILITY STATEMENT

Raw data is available directly with the author.

DECLARATION OF USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was used to assist language correction.

REFERENCES

- ABCCC. ASSOCIAÇÃO BRASILEIRA DE CRIADORES DE CAVALOS CRIoulos. 2025. Available from: <<https://www.cavalocrioulo.org.br/>>. Accessed: Dez. 20, 2025.
- BURGER, D. et al. Effects of ground semen collection on weight bearing on hindquarters, libido, and semen parameters in stallions. *Theriogenology*, v.84, n.5, p.687-692, 2015. Available from: <<https://pubmed.ncbi.nlm.nih.gov/26050613/>>. Accessed: Apr. 04, 2025. doi: 10.1016/j.theriogenology.2015.04.029.

- CANISSO, I. F. et al. Sexual behavior and ejaculate characteristics in Pêga donkeys (*Equus asinus*) mounting estrous horse mares (*Equus caballus*). **Theriogenology**, v.73, n.1, p.56-63, 2010. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0093691X09003719>>. Accessed: Apr. 04, 2025. doi: 10.1016/j.theriogenology.2009.07.026.
- FREITAS, B. W. A. K. et al. Sexual behavior of Criollo stallions on pasture. **Animal Reproduction Science**, n.94, p.42-45, 2006. Available from: <https://www.academia.edu/100922382/Sexual_behavior_of_Criollo_stallions_on_pasture>. Accessed: Apr. 04, 2025. doi: 10.1016/J.ANIREPROSCI.2006.03.022.
- HENRY, M. et al. Pasture mating behavior of donkeys (*Equus asinus*) under natural and induced oestrus. **Journal of Reproduction and Fertility**, Suppl. 44, p.77-86, 1991. Available from: <<https://pubmed.ncbi.nlm.nih.gov/1795305/>>. Accessed: Apr. 04, 2025.
- HOUSSOU, H. et al. Evaluation of sexual behavior of stallion (Arabian versus Barb) during breeding season in Algeria. **Indian Journal of Animal Research**, v.54, p.1078-1082, 2020. Available from: <<https://arccjournals.com/journal/indian-journal-of-animal-research/B-950>>. Accessed: Apr. 04, 2025. doi: 10.18805/ijar.B-950.
- IONATA, L. M. et al. Characteristics of stallions in novel and in routine semen collection sites, with or without restraint. **Theriogenology**, v.36, p.913-921, 1991. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0093691X91903177>>. Accessed: Apr. 04, 2025. doi: 10.1016/0093-691X(91)90317-7.
- MCDONNELL, S. M. Normal and abnormal sexual behavior. **Veterinary Clinics of North America: Equine Practice**, v.8, p.71-89, 1992. Available from: <<https://pubmed.ncbi.nlm.nih.gov/1576555/>>. Accessed: Apr. 04, 2025. doi: 10.1016/S0749-0739(17)30467-4.
- MCDONNELL, S. M. Reproductive behavior of stallions and mares: comparison of free-running and domestic in-hand breeding. **Animal Reproduction Science**, v.60-61, p.211-219, 2000. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0378432000001366>>. Accessed: Apr. 04, 2025. doi: 10.1016/S0378-4320(00)00136-6.
- MCDONNELL, S. M. Stallion sexual behavior. In: SAMPER, J. C. (Ed.), **Equine Breeding Management and Artificial Insemination**, second ed. Saunders, Elsevier Inc., Missouri, pp.41-46, 2009.
- NAJJAR, A. et al. Determination of semen and sexual behavior parameters of Arabian stallions to be selected for an artificial insemination program under Tunisian conditions. **American-Eurasian Journal of Agricultural & Environmental Sciences**, v.8, p.173-177, 2010. Available from: <<https://hal.science/hal-01129474>>. Accessed: Apr. 04, 2025.
- NOUE, P. et al. Sexual behavior of stallions during in-hand natural service and semen collection: an observation in French studs. **Animal Reproduction Science**, v.68, p.161-169, 2001. Available from: <<https://pubmed.ncbi.nlm.nih.gov/11744261/>>. Accessed: Apr. 04, 2025. doi: 10.1016/S0378-4320(01)00153-1.
- RIBEIRO, N. L. et al. Reproductive behavior and libido of Nordeste breed stallions in an equatorial climate. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.77, n.4, p.1-11, 2025. Available from: <<https://www.scielo.br/j/abmvz/a/fqNDR4mWcFQbSjpxdgVyKCC/?format=html&lang=en>>. Accessed: Apr. 04, 2025. doi: 10.1590/1678-4162-13445.
- ROBALO SILVA, J. et al. Seasonal variation of testicular size, semen production and sexual behaviour of Lusitano stallions. **Revista Portuguesa de Ciências Veterinárias**, v.102, p.119-125, 2007. Available from: <<https://www.cabidigitallibrary.org/doi/full/10.5555/20093020779>>. Accessed: Apr. 04, 2025.
- RUA, M. A. S. et al. Evaluation of the sexual behavior and testosterone concentrations of Mangalarga Marchador stallions. **Applied Animal Behaviour Science**, v.171, p.101-107, 2015. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0168159115002178>>. Accessed: Apr. 04, 2025. doi: 10.1016/j.applanim.2015.08.014.
- RUA, M. A. S. et al. Evaluation of the breeding behavior of Brazilian Pony stallions. **Animal Reproduction Science**, v.172, p.137-142, 2016. Available from: <<https://pubmed.ncbi.nlm.nih.gov/27461953/>>. Accessed: Apr. 04, 2025. doi: 10.1016/j.anireprosci.2016.07.011.
- RUA, M. A. S. et al. Evaluation of the libido of Pantaneiro stallions. **Revista Brasileira de Zootecnia**, v.49, 2020. Available from: <<http://scielo.br/j/rbz/a/6Z8b5kkB9hvbSFhzk9CMBDj/?lang=en>>. Accessed: Apr. 04, 2025. doi: 10.37496/rbz4920190238.
- SAHIN, D. et al. The number of false mounting affects the quality of semen in bulls. **Livestock Studies**, v.60, n.1, p.9-15, 2020. Available from: <<https://livestockstudies.org/abstract.php?lang=en&id=822>>. Accessed: Apr. 04, 2025. doi: 10.46897/lahaed.701388.
- STAHLBAUM, C. C.; HOUP, K. A. The physiology of the role of the Flehmen response in the behavioral repertoire of the stallion. **Physiology & Behavior**, v.45, p.1207-1214, 1989. Available from: <<https://pubmed.ncbi.nlm.nih.gov/2813545/>>. Accessed: Apr. 04, 2025. doi: 10.1016/0031-9384(89)90111-x.
- VERONESI, M. C. et al. Oxytocin, vasopressin, prostaglandin F_{2α}, luteinizing hormone, testosterone, estrone sulfate and cortisol plasma concentrations after sexual stimulation in stallions. **Theriogenology**, v.73, p.460-467, 2010. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0093691X09004567>>. Accessed: Apr. 04, 2025. doi: 10.1016/j.theriogenology.2009.09.028.
- WAHEED, M. M. et al. Sexual behavior and hormonal profiles in Arab stallions. **Journal of Equine Veterinary Science**, v.35, p.499-504, 2015. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0737080615000611>>. Accessed: Apr. 04, 2025. doi: 10.1016/j.jevs.2015.01.022.