

Effect of Platelet-Rich Plasma on Uterine Regeneration for Bovine Reproductive Improvement

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ABSTRACT

The objective of this research was to evaluate the effect of platelet-rich plasma (PRP) on uterine regeneration to improve the reproductive performance of cattle affected by perinatal diseases in production units in the Sabana Grande sector, Mauroa Municipality, Falcón State. The study employed a quantitative, experimental field approach, using a comparative design between an experimental group and a control group. The sample consisted of ten crossbred cows (5 control and 5 experimental), selected according to established research criteria and divided into two groups of five animals each. The experimental group received PRP as a regenerative treatment, while the control group received the conventional management practices used in the production units. Results were evaluated through continuous clinical observation, focusing on uterine recovery, the course of the puerperium, the presence or absence of clinical signs associated with reproductive disorders, and the return to normal ovarian activity. The results showed a favorable response in the PRP-treated animals, characterized by faster recovery of uterine physiological conditions, a reduction in inflammatory signs, and a quicker return to estrus compared to the control group. Furthermore, no adverse effects associated with the treatment were recorded, demonstrating its safety and viability as a therapeutic alternative in veterinary practice. The findings indicate that PRP promotes uterine tissue regeneration, helps shorten the puerperal period, and improves the reproductive efficiency of the treated animals. In conclusion, the administration of PRP in the experimental group demonstrated a faster recovery of intrauterine involution compared to the control group, representing an innovative, safe, and effective biological tool for improving bovine reproductive health, optimizing production indices, and contributing to the sustainable development of livestock production systems.

Keywords: Platelet-Rich Plasma, Uterine Regeneration, Bovines, Perinatal Diseases, Reproductive Efficiency, Puerperium, Return to Heat

INTRODUCTION

Various recent studies have shown that uterine abnormalities remain a major limiting factor for bovine reproductive performance, particularly

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in production systems where females face variable sanitary conditions and inconsistent management practices. Consequently, authors such as Crermonsi [1] state that “endometrial dysfunctions reduce reproductive efficiency and prolong calving intervals” (p. 41), which directly impacts the productivity and economic stability of livestock operations.

Against this backdrop, the use of biological therapies such as platelet-rich plasma (PRP) has gained prominence; its intrauterine application offers a regenerative approach based on growth factors capable of stimulating tissue repair. Recent research has demonstrated that PRP can facilitate the recovery of the affected endometrium and improve uterine receptivity, thereby opening up possibilities for optimizing reproductive indices in cattle herds exposed to environmental or sanitary stress.

Along these lines, Cremonesi [2] maintains that “PRP constitutes a therapeutic alternative with the potential to reduce inflammatory processes and promote cellular regeneration in reproductive tissues” (p. 58). Thus, incorporating it into reproductive management protocols could represent a significant advancement for producers seeking to reduce conception failures; available evidence suggests that PRP intervention can be integrated into traditional practices without negatively affecting animal physiology.

It is worth noting that uterine disorders not only compromise female fertility but also result in economic losses associated with repeated treatments, reduced pregnancy rates, and an increase in “days open.” Consequently, the lack of regenerative strategies tailored to bovine production conditions limits the ability to respond to recurrent reproductive issues, thereby affecting the sustainability of livestock systems.

In this regard, Cuadros and Sandoval [3] states the following: The application of platelet-rich plasma to the bovine reproductive tract has demonstrated positive effects on endometrial regeneration due to the controlled release of bioactive proteins that modulate inflammation and stimulate cell proliferation, thereby enabling faster tissue recovery and improving the reproductive capacity of treated females (p. 3).

Against this backdrop, the issues described are also evident in cattle production units located in the Sabana Grande

sector of Mauroa Municipality, Falcón State. There, females subjected to the management practices typical of traditional livestock systems suffer from perinatal conditions that compromise uterine regeneration and delay the resumption of reproductive activity. This situation negatively impacts fertility rates, prolongs the calving interval, and reduces the productivity of livestock operations, resulting in economic losses for local producers. Consequently, there is a need to evaluate innovative therapeutic alternatives—such as platelet-rich plasma (PRP)—given its potential to promote uterine tissue regeneration, accelerate postpartum recovery, and improve reproductive efficiency in cattle within this geographic context.

From this perspective, PRP emerges as a tool that prompts a reconsideration of how uterine pathologies in cattle are addressed. Its biological action demonstrates that tissue regeneration relies not only on conventional pharmacological treatments but also on the use of autologous components capable of activating natural repair processes—an approach that is particularly valuable in settings where resources are limited and maximizing reproductive efficiency is essential.

As noted by Yamate and Katagiri [4], “the implementation of regenerative therapies enables producers to better understand uterine recovery dynamics and adopt practices more aligned with the animal’s physiological needs” (p. 44); consequently, the use of PRP in female cattle within the production sector could help reduce the incidence of reproductive failure, strengthen uterine health, and improve outcomes for artificial insemination or natural breeding programs.

In this context, the present study aims to evaluate the effect of platelet-rich plasma on uterine wall regeneration in cattle affected by perinatal conditions—specifically in females managed under traditional livestock farming systems—thereby seeking to provide information to assess the suitability of this therapy as a complementary alternative for treating uterine disorders.

METHODOLOGY

This research is quantitative in nature and employs an experimental field design, as it involves two study groups (a PRP-treated group and a control group) without strict random assignment, yet with direct manipulation of the independent variable. According to Corona and Kovac [5], an

experimental design “involves the manipulation of variables and comparison between groups, albeit without absolute control over random assignment.” The study sample consisted of ten non-primiparous crossbred female cattle (5 control and 5 experimental) in the postpartum stage, sourced from production units in the Sabana Grande sector (Mauroa Municipality, Falcón State) and monitored between November 2025 and 2026.

Data collection techniques and instruments included direct observation (to record behaviors and processes as they occur in their natural context) and gynecological evaluation, which was carried out daily. The latter provided an in-depth look at the condition of the uterus, revealing details observable only through direct examination. Its application in this study allowed for the identification of irregularities, abnormal textures, signs of regeneration, and the immediate tissue response to PRP.

Data recording sheets were also used; these served as the instrument for logging data obtained during each gynecological evaluation of the cattle, tracking variables such as uterine involution, the presence or absence of abnormal vaginal secretions, cervical characteristics, uterine consistency and size, and the return to estrus.

A PRP centrifuge was used to separate blood components *via* centrifugal force, enabling the production of platelet concentrates.

Data analysis initially employed descriptive statistics: means, percentages, and standard deviations. According to Corona and Maldonado [6], descriptive statistics encompass the methods used to organize, summarize, and present data in an

informative manner. This approach allowed for the synthesis of clinical and reproductive information obtained during the experimental process. Means facilitated the interpretation of general trends in uterine regeneration; percentages helped visualize the proportion of animals showing improvement; and standard deviations revealed inter-individual variability. Together, these indicators provided a clear, structured overview of PRP performance within the evaluated bovine population.

RESULTS

Optimization of the Platelet-Rich Plasma (PRP) Extraction Protocol

The protocol for extracting Platelet-Rich Plasma (PRP) from bovine blood ensured a high platelet concentration and yielded a biological product with characteristics suitable for therapeutic application. To achieve this, a standardized PRP collection procedure was established using an anticoagulant and a double-centrifugation process, which effectively facilitated the separation of the various blood fractions.

Blood was obtained *via* jugular venipuncture, collecting a volume of 120 cc per animal; ethylenediaminetetraacetic acid (EDTA) was used as the anticoagulant to preserve platelet integrity and prevent clotting during processing. Subsequently, the samples underwent an initial centrifugation at 1,000 revolutions per minute for nine (9) minutes to separate erythrocytes from the plasma. A second centrifugation was then performed at 3,000 revolutions per minute for twenty (20) minutes, yielding a final concentrate of 20 cc of Platelet-Rich Plasma suitable for therapeutic application.

Table 1: Optimized protocol for obtaining Platelet-Rich Plasma (PRP)

Parameter evaluation	Result obtained
Volume of bloom	120 cc
Anticoagulante utilizado	EDTA
Primera centrifugación	1000 rpm for 9 minutes
Segunda centrifugación	3000 rpm durante 20 minutos
Final volume of PRP obtained	20 cc
Appearance of PRP	Homogeneous

The results indicate that the protocol used yielded a platelet concentrate suitable for clinical use while maintaining appropriate conditions for platelet processing and preservation. The combination of the extracted blood volume, the use of EDTA anticoagulant, and a double-centrifugation process facilitated efficient blood component separation and the production of plasma with a high platelet concentration—a crucial factor for enhancing the release of growth factors involved in tissue repair and regeneration.

From a technical standpoint, standardizing the procedure was key to ensuring the reproducibility of the treatment across all animals in the experimental group. Consistently obtaining 20 cc of Platelet-Rich Plasma allowed for the administration of a uniform dose to each treated bovine *via* intrauterine infusion, thereby reducing experimental variability and strengthening the reliability of the study's results.

These findings align with Corona [7], who note that the therapeutic efficacy of Platelet-Rich Plasma depends largely on the proper standardization of the preparation protocol; factors such as centrifugation conditions, processed blood volume, and the type of anticoagulant directly influence the final platelet concentration and, consequently, the quantity of growth factors available to stimulate tissue regeneration. Similarly, Cuadros and Sandoval [3] highlight that implementing standardized protocols facilitates the production of higher-quality biological preparations, thereby increasing treatment effectiveness and ensuring

more consistent clinical outcomes.

Based on the results, it can be concluded that the extraction protocol successfully met the research's first specific objective by ensuring the production of Platelet-Rich Plasma with characteristics suitable for therapeutic application and subsequent evaluation regarding uterine regeneration in cattle affected by perinatal diseases.

Determination of the Time Required for Complete Uterine Wall Regeneration in Cattle Treated with Platelet-Rich Plasma

Evaluation was conducted through periodic clinical observation during the postpartum period, using the following recovery indicators: uterine involution, resolution of inflammatory signs, absence of pathological secretions, and resumption of reproductive activity evidenced by the return to estrus.

The results demonstrated significant differences between the two experimental groups. Females treated with Platelet-Rich Plasma exhibited faster uterine regeneration, achieving satisfactory clinical recovery between thirty (30) and thirty-five (35) days post-treatment. In contrast, cows in the control group showed a slower recovery; the restoration of reproductive conditions was observed starting fifty (50) days after calving, with the process extending even further in some cases due to the persistence of abnormalities associated with the postpartum period.

Table 2: Uterine regeneration time observed in the evaluated groups

Evaluated Group	Number of Animals	Average Uterine Regeneration Time Experimental
Experimental (PRP)	5	30–35 days
Control	5	50 days or more

The data indicate that the application of Platelet-Rich Plasma (PRP) reduced the time required for uterine regeneration by approximately fifteen (15) to twenty (20) days compared to the control group. This difference represents a significant advantage from both clinical and productive standpoints, as earlier uterine recovery facilitates the timely resumption of reproductive activity and shortens the calving interval—a fundamental factor for improving reproductive efficiency in cattle operations.

Clinical monitoring revealed that cows in the experimental group experienced faster uterine involution, evidenced by a progressive decrease in uterine size, improved uterine wall consistency, and an absence of abnormal secretions compared to the control group. Furthermore, the treated animals showed more uniform clinical recovery, with no complications that would delay the tissue repair process.

From a physiological perspective, these results can be attributed to the action of growth factors present in PRP—such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF- β), and vascular endothelial growth factor (VEGF)—which stimulate cell proliferation, promote angiogenesis, increase collagen synthesis, and accelerate the natural repair mechanisms of injured tissues. Consequently, the endometrium regains its anatomical and functional characteristics more rapidly, allowing for the early restoration of the females' reproductive capacity.

These findings align with the work of Caterino et al. [8], who state that PRP application promotes tissue regeneration through the progressive release of growth factors that stimulate healing and cellular repair processes. Likewise, Cuadros and Sandoval [3] maintain that PRP is an effective biological alternative for accelerating the recovery of injured tissues, significantly reducing repair time compared to conventional treatments. Based on the results obtained, it can be stated that the application of Platelet-Rich Plasma reduced the time required for uterine regeneration in the evaluated female cattle; this successfully met the study's

second specific objective and demonstrated the therapeutic potential of PRP to facilitate a faster and more efficient reproductive recovery.

Determination of the Effect of Platelet-Rich Plasma On the Duration of the Puerperal Period

Continuous clinical evaluation of the females was performed during the puerperium, recording the process of uterine involution, the presence or absence of abnormal vaginal secretions, the persistence of inflammatory processes, and the general recovery of the reproductive tract.

The findings revealed a more favorable clinical progression in cows treated with Platelet-Rich Plasma, with a faster and more uniform recovery observed compared to the control group. No persistent pathological uterine secretions or clinical signs indicative of severe inflammatory processes were detected in the females of the experimental group during the observation period. In contrast, some cows in the control group exhibited slower uterine involution and clinical signs that prolonged the puerperal period.

Table 3: Clinical assessment of the puerperal period in the studied groups

Clinical variable	PRP group	Control group
Adequate uterine involution	5	3
Presence of abnormal secretions	0	2
Persistent inflammatory	0	2
Satisfactory postpartum recovery	5	3

The results show that one hundred percent (100%) of the cows treated with Platelet-Rich Plasma (PRP) exhibited a favorable postpartum recovery, characterized by adequate uterine involution and the absence of relevant clinical alterations. In contrast, the control group showed a less uniform recovery, with some animals exhibiting abnormal secretions and persistent inflammatory processes, conditions that delayed the functional recovery of the reproductive system.

From a reproductive standpoint, the reduction in the duration of the postpartum period is one of the main benefits associated with the application of PRP, as it promotes the early restoration of the uterine environment, allowing for

the timely resumption of ovarian cycles and increasing the chances of achieving new pregnancies in a shorter period.

These results are consistent with those reported by Consiglio et al. [9], who states that rapid and uncomplicated uterine involution is one of the main indicators of reproductive recovery in cattle. Furthermore, Carmona et al. (2018) maintain that the growth factors present in Platelet-Rich Plasma (PRP) accelerate tissue repair mechanisms and decrease the inflammatory response, promoting a more efficient clinical recovery.

Consequently, the results obtained allow us to affirm that the application of PRP contributed to reducing the duration of

the puerperal period, as detailed in Table 3, and promoted faster uterine recovery in the evaluated bovine females.

Examination of the Incidence of Potential Adverse Effects and Evaluation of Return to Estrus in Cattle Treated with Platelet-Rich Plasma (PRP)

Concurrently, the return to estrus was evaluated as the main clinical indicator of the restoration of reproductive activity, considering that the reappearance of estrus constitutes a physiological manifestation of the proper functioning of the reproductive system once the uterine regeneration process is complete.

During the clinical follow-up period, no adverse reactions related to the application of Platelet-Rich Plasma were recorded. None of the treated cows presented secondary infectious processes, severe inflammatory reactions, systemic alterations, tissue necrosis, or clinical signs compatible with treatment rejection. Likewise, all animals maintained an adequate general state of health, demonstrating good body condition, normal behavior, and no complications following PRP administration.

As part of the reproductive evaluation, the return to estrus was also recorded in both experimental groups. The results showed that all females treated with Platelet-Rich Plasma showed clear signs of estrus within the observation period, while only three animals belonging to the control group showed estrous activity during the same follow-up period.

These results demonstrate that the application of Platelet-Rich Plasma (PRP) did not produce adverse effects in any of the treated animals, confirming the biological safety of the procedure. The autologous nature of PRP significantly reduces the risk of immunological incompatibility, since the platelet concentrate is obtained from the blood of the same animal receiving the treatment, thus reducing the possibility of rejection reactions or clinical complications.

Furthermore, the return to estrus observed in one hundred percent (100%) of the treated cows constitutes clinical evidence of the functional recovery of the reproductive system. The manifestation of estrus signs, such as restlessness, frequent vocalization, vulvar edema, the presence of clear cervical mucus, and acceptance of mounting, confirmed that the physiological processes of uterine regeneration developed satisfactorily in the experimental group.

In contrast, the females in the control group showed a less uniform reproductive recovery, with a delay in the onset of estrus observed in two animals that did not exhibit estrus activity during the evaluation period. This behavior suggests that the absence of regenerative treatment may have influenced a slower uterine recovery and, consequently, a delay in the resumption of ovarian activity.

DISCUSSION

The platelet-rich plasma (PRP) extraction and preparation protocol yielded a biological concentrate with characteristics suitable for clinical use. One hundred and twenty cubic centimeters (120 cc) of bovine blood, EDTA anticoagulant, and a double centrifugation procedure were used: 1000 rpm for nine minutes and 3000 rpm for twenty minutes, ultimately yielding twenty cubic centimeters (20 cc) of platelet-rich plasma. Standardizing this procedure ensured uniformity of the applied treatment and reduced experimental variability, a crucial aspect considered by Chang et al. [10] who assert that PRP quality depends directly on the preparation protocol.

It was observed that cows treated with platelet-rich plasma achieved uterine regeneration between thirty (30) and thirty-five (35) days post-treatment, while the control group showed recovery after more than fifty (50) days. This difference demonstrates that the application of PRP accelerated the physiological processes of tissue repair, promoting faster uterine involution and reducing the time required to restore normal reproductive conditions. These results are consistent with those reported by Gonçalves, Frantz, de Oliveira [11], who describe how the growth factors present in platelets promote cell proliferation, angiogenesis, and the regeneration of damaged tissues.

Clinical evaluation of the puerperal period showed a significantly more favorable outcome in the females treated with Platelet-Rich Plasma. During clinical follow-up, adequate uterine involution, absence of pathological secretions, and disappearance of inflammatory signs were observed in all cows in the experimental group, while some females in the control group showed a slower recovery and persistence of clinical alterations typical of the puerperium. These findings support the observations of Yang, Zhang and Zhang [12], who maintains that adequate uterine involution is one of the main indicators of reproductive efficiency in cattle.

Furthermore, it was demonstrated that the application of Platelet-Rich Plasma (PRP) did not produce adverse effects in any of the treated animals, evidencing the safety of the therapeutic procedure used. Additionally, a return to estrus was observed in one hundred percent (100%) of the cows in the experimental group, while only sixty percent (60%) of the females in the control group exhibited estrous activity during the evaluation period. These results constitute clinical evidence of the functional restoration of the reproductive system and are consistent with Segabinazzi [13] and Zhou et al [14], who highlights that the autologous origin of PRP considerably reduces the occurrence of adverse reactions and promotes more efficient tissue recovery, making it an effective therapeutic alternative to promote the regeneration of uterine walls and improve the reproductive efficiency of cattle affected by perinatal diseases.

CONCLUSION

It is concluded that PRP constitutes an effective therapeutic alternative for promoting the regeneration of uterine walls and improving the reproductive efficiency of cattle affected by perinatal diseases. Furthermore, the reduction in the time required for uterine regeneration and the duration of the puerperal period, the absence of adverse effects, and the early return to estrus provide clinical evidence supporting the use of PRP as an innovative biotechnological tool within bovine reproductive management programs.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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