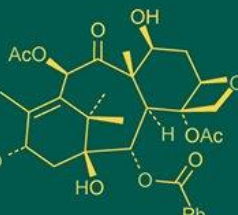
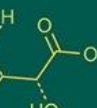
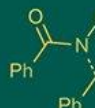


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Enhancing reproductive efficiency: Antiluteolytic strategies for luteal support in livestock

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Abstract

India's livestock sector, with a population of over 535 million animals, plays a critical role in rural livelihoods and national dairy production. Despite this growth, reproductive inefficiencies-especially early embryonic loss-continue to hinder productivity. Fertilization rates in cattle are high, yet conception rates remain suboptimal due to failures in maternal recognition and luteal maintenance. To address these challenges, interventions such as GnRH, HCG, progesterone supplementation, NSAIDs, omega-3 fatty acids, and IFNT signaling have been explored. These strategies aim to enhance corpus luteum function, reduce prostaglandin-induced luteolysis, and support early pregnancy. While results vary depending on timing, species, and physiological condition, evidence supports their potential in improving conception outcomes and reproductive efficiency in farm animals.

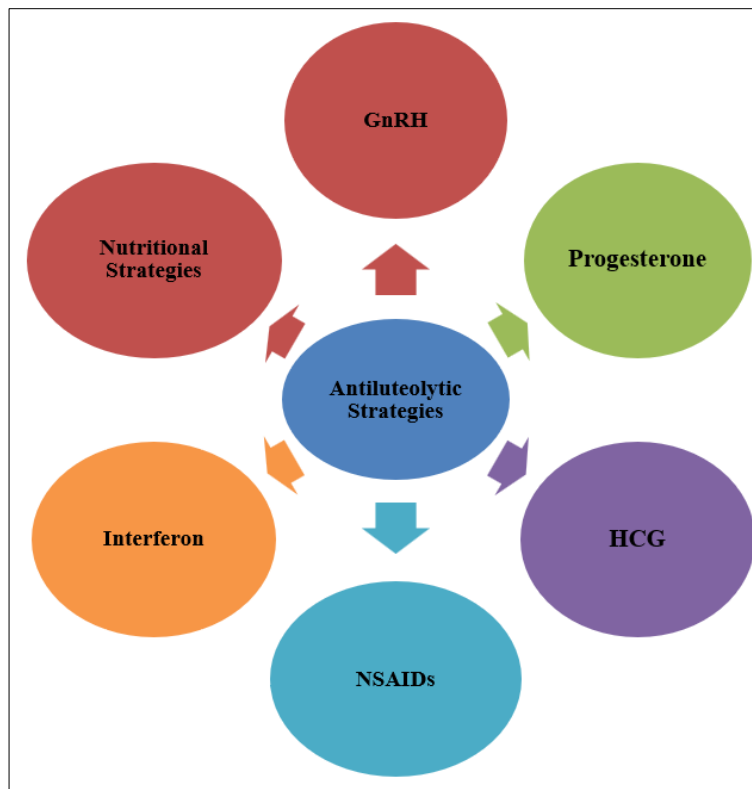
Keywords: NSAIDs, IFNT, n-3 PUFAs, embryo death, fertilization

Introduction

India's livestock sector forms a vital component of the national agricultural economy, playing a key role in sustaining rural livelihoods and contributing significantly to dairy production. According to the 2019 Livestock Census, the country's livestock population reached 535.78 million, an increase of 4.6% from the previous census-with cattle alone accounting for 192.49 million (Press Information Bureau, Government of India, 2019) [42]. Despite this substantial growth, reproductive inefficiencies remain a critical challenge, adversely impacting productivity and economic sustainability.

Reproduction in cattle is a tightly regulated biological process that relies on precise communication between the embryo and the maternal system for successful pregnancy recognition, implantation, and placentation (Guillomot, 1995; Spencer *et al.*, 2007) [14, 58]. In normal polycyclic animals, luteolysis occurs and the animal returns to estrus if the oocyte is not fertilized while if fertilization does occur, luteolysis must be inhibited-typically around Day 16 post-estrus-to ensure the establishment and maintenance of pregnancy (Binelli *et al.*, 2001) [6]. This suppression depends on the conceptus's ability to produce strong antiluteolytic signals and the endometrium's capacity to respond by inhibiting the secretion of prostaglandin F_{2α} (PGF_{2α}) (Binelli *et al.*, 2001) [6]. The fertilization rates can reach nearly 100% in heifers (Santos *et al.*, 2004) [46] and about 77-90% in dairy cows, conception rates measured between days 27 and 31 post-AI are significantly lower, ranging from only 35 to 45% (Diskin and Sreenan, 1980, Thatcher *et al.*, 1994, Sreenan *et al.*, 2001, Sartori *et al.*, 2002) [9, 62, 59, 48]. Hence, in spite of the high fertilization rate, the conception rate is very low because of failure in the effective suppression of the luteolysis mechanism. However, fertilization failure accounts for only about 10% of overall reproductive failure while embryo death accounts for more than 30% and major portion of this embryo loss would seem to occur between days 8 and 16 (Diskin and Sreenan, 1980) [9]. These reproductive challenges underline the necessity for effective antiluteolytic strategies aimed at supporting corpus luteum (CL) function and minimizing early pregnancy loss. Consequently, various interventions have been developed to extend CL lifespan and enhance embryo viability in farm animals.

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GnRH

The gonadotrophin releasing hormone (GnRH) modulates the secretion of luteinizing hormone (LH), and the endogenous surge of LH during estrus which is responsible for ovulation and luteinization of granulosa and theca cells for progesterone secretion (Henderson, 1979) ^[17]. All this happens via the hypertrophy and increased blood flow to the CL (Farin *et al.*, 1988; Niswender *et al.*, 1976) ^[10, 38]. However the effect of a single injection (day 12) of GnRH or hCG reported no improvement in the fertility of the ewes (Ishida *et al.*, 1999) ^[20].

Early treatment with GnRH (Howard *et al.*, 2006) ^[19] has proved to be more effective compared with late treatment, GnRH injections given on day 5 of the estrous cycle consistently induced ovulation of the dominant follicle giving accessory CL (Schmitt *et al.*, 1996) ^[51] however other study reported only 60% cows with accessory CL administered with GnRH between day 4 to 9 following AI (Howard *et al.*, 2006; Santos *et al.*, 2001; Stevenson *et al.*, 2007) ^[19, 47, 60]. Others have reported that animals administered GnRH after day 10 of AI had higher pregnancy per AI as compared to GnRH treatment before day 10 of AI. The opinion of Giordano *et al.* (2012) ^[13] suggests that formation of accessory CL during the period of the first follicular wave resulted in a significant increase in pregnancy rate as it creates a favourable uterine environment for embryonic development by increasing the levels of progesterone during the early phases of embryonic development.

HCG

The administration of Human Chorionic Gonadotropin (HCG) has been widely studied as an antiluteolytic strategy to improve conception rates in cattle, particularly in repeat breeders. Karsavuranoğlu *et al.* (2022) ^[21] reported that conception rates were similar in groups treated with GnRH alone and those treated with a combination of GnRH and

HCG, suggesting no added benefit from combining the two. In contrast, Thakur *et al.* (2018) ^[61] found that HCG administration, whether at the time of artificial insemination (AI) or on the 5th or 12th day post-AI, resulted in improved conception rates in cattle. Similarly, Lim *et al.* (2018) ^[25] observed increased conception rates in dairy cows when HCG was administered on the 5th day post-AI.

Miura *et al.* (2018) ^[32] reported enhanced conception success specifically in cattle possessing a first-wave dominant follicle (DF) in the ovary ipsilateral to the corpus luteum (CL), when HCG was administered on day 5 after AI. Rahman *et al.* (2021) ^[43] also found a beneficial effect of HCG administration either at the time of AI or within a few days post-AI in repeat-breeding cows. Parikh *et al.* (2018) ^[40] observed improved conception rates with both HCG and GnRH administration. Additionally, Santos *et al.* (2001) ^[47] reported that the use of HCG enhanced conception rates in dairy cattle, which was attributed to the formation of accessory corpora lutea, thereby supporting luteal function and early pregnancy maintenance.

Progesterone

Several studies have investigated the role of progesterone supplementation in enhancing fertility in cattle, particularly among animals with reproductive challenges. Friedman *et al.* (2012) ^[11] reported that Controlled Internal Drug Release (CIDR) devices containing progesterone improved fertility in cows with low body condition scores (BCS) and postpartum disorders, especially during the summer months. Awasthi *et al.* (2002) ^[5] also observed improved conception rates in crossbred cows when progesterone was administered during the mid-luteal phase of the estrous cycle. Similarly, Singh, *et al.* (2008) ^[52] demonstrated that progesterone treatment significantly enhanced conception rates in repeat-breeding cattle. Supporting this, Ababneh *et al.* (2007) ^[1] found that administering progesterone after insemination led to higher conception success. Kumar *et al.*

(2012) ^[23] noted that progesterone administration on the 3rd or 5th day post-insemination had a positive effect on conception rates in repeat breeders.

However, not all findings were uniformly positive. Parikh *et al.* (2018) ^[40] suggested that while progesterone supplementation does have beneficial effects, it is generally less effective than treatments involving HCG or GnRH. More recently, Modaresi *et al.* (2024) ^[33] proposed that the use of sustained-release progesterone formulations could be especially useful in managing fertility in repeat-breeding cows. On the other hand, Kumar *et al.* (2025) ^[24] reported that progesterone supplementation showed no significant improvement in conception rates in buffaloes, indicating that species-specific differences and management practices may influence outcomes. These varying results underscore the need for further research to better understand the optimal conditions and protocols for progesterone use in different breeds and production systems.

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

PGF_{2α} is synthesized from arachidonic acid through a cascade of enzymatic reactions involving cyclooxygenase-2 (COX-2). Various COX-2 inhibitors such as meloxicam, aspirin, and flunixin meglumine have been studied by researchers for their potential to suppress prostaglandin production and thereby enhance conception rates in livestock. Singh *et al.* (2021) ^[53] noted that invasive reproductive procedures can trigger stress-induced prostaglandin release, negatively impacting progesterone levels and pregnancy maintenance. NSAID administration in such cases helps counteract this effect by inhibiting COX activity and reducing inflammatory responses.

Merrill *et al.* (2007) ^[31] reported that administration of flunixin meglumine (FM) improved conception rates in cattle. Similarly, Skidmore *et al.* (2002) ^[55] observed a reduction in PGFM concentrations in camels treated with FM prior to embryo transfer (ET). Supporting these findings, Scenna *et al.* (2005) ^[49] demonstrated an increased pregnancy rate following FM administration at the time of ET in cattle. Damarany and Ghanem (2020) ^[8] also confirmed the beneficial effects of FM in improving conception rates in Egyptian Baladi cows during the hot season. Alkan *et al.* (2021) ^[4] concluded that carprofen administration post-artificial insemination (AI) enhanced conception rates in cattle that had experienced prolonged infertility postpartum.

Regarding meloxicam, Rajkumar *et al.* (2010) ^[44] reported a 20% improvement in conception rates in buffaloes treated with meloxicam compared to the control group. Similarly, Aguiar *et al.* (2013) ^[2] found that meloxicam treatment improved conception rates after ET in heifers.

Tolfenamic acid has also shown promising results. Schlapp *et al.* (2015) ^[50] reported that its administration during ET in mice improved pregnancy rates and pup survival. Maithani *et al.* (2023) ^[28] further demonstrated that tolfenamic acid enhanced conception rates after ET by reducing PGFM levels and increasing progesterone concentrations. Additionally, Singh *et al.* (2020) ^[54] found that tolfenamic acid administration post-AI improved conception rates in repeat breeder cattle. Kasimanickam *et al.* (2018) ^[22] reported improved conception rates in temperamentally sensitive beef cows following embryo transfer when flunixin meglumine (FM), an NSAID, was used. Schlapp *et al.* 2015 ^[50] reported administration of Tolfenamic Acid at

the time of ET improve both maintenance of pregnancy and embryo survival. Spencer *et al.* 2020 ^[56] concluded that NSAID in form of FM or ibuprofen improve the conception rate if administered at the time of ET.

Collectively, these findings highlight the potential of NSAID-based interventions in improving conception outcomes, minimizing early embryonic loss, and supporting overall reproductive efficiency in both livestock and laboratory animal models.

Omega-3 Polyunsaturated Fatty Acids (n-3 PUFAs)

Dietary supplementation with omega-3 polyunsaturated fatty acids (n-3 PUFAs), primarily sourced from fish oil and linseed, has demonstrated positive effects on reproductive performance in various farm animal species. These fatty acids are known to modulate prostaglandin synthesis, steroid hormone profiles, and ovarian function, ultimately enhancing fertility.

Mahala *et al.* (2016, 2017) ^[27, 26] reported that supplementation of goats with n-3 PUFA-rich fish oil delayed the onset of PGF_{2α}-induced estrus, suggesting a potential role in modulating luteolysis and extending the luteal phase. Verma *et al.* (2018) ^[65] further concluded that dietary fish oil inhibits oxytocin (OXT)-induced PGF_{2α} release and reduces estradiol (E₂) concentrations during the late luteal phase in does, thereby supporting maternal recognition of pregnancy. Verma *et al.* (2017) ^[64] also found that n-3 PUFA supplementation alters serum biochemical profiles, including a dose-dependent reduction in blood cholesterol, an essential precursor for steroid hormones such as estrogen, potentially optimizing the hormonal environment for reproduction.

In buffaloes, Nazir *et al.* (2013) ^[36] demonstrated that dietary supplementation with crushed flaxseed improved conception rates by attenuating luteolytic signals and enhancing the post-breeding luteal profile. Similarly, Akhtar *et al.* (2024) ^[3] reported increased serum progesterone (P₄) concentrations following linseed supplementation in sheep, indicating improved luteal function. In cattle, Girgo *et al.* (2020) ^[12] observed significantly higher conception rates (58.30% vs. 33.33%) and markedly reduced embryo mortality (14.30% vs. 50.00%) in cows receiving n-3 PUFA supplementation compared to controls. Gulliver *et al.* (2012) ^[15] found that n-3 PUFA supplementation extended the interval to estrus and parturition, correlating this delay with reduced PGF_{2α} levels. Mohammed *et al.* (2024) ^[34] reported that dietary inclusion of extruded flaxseed (7.0%) or salmate (25 g/head/day) during the transition period until six months postpartum in commercial Holstein cows significantly accelerated ovarian activity and improved conception rates. Moreover, Pereira *et al.* (2021) ^[41] highlighted the benefits of n-3 PUFA in improving fertility among high-yielding dairy cows by promoting early postpartum conception.

Collectively, these findings support the strategic inclusion of n-3 PUFA-rich feed sources such as fish oil and flaxseed in the diets of farm animals as a means to enhance reproductive performance, reduce early embryonic losses, and improve conception outcomes.

Interferon Tau (IFNT)

Interferon tau (IFNT) plays a crucial role in maternal recognition of pregnancy in ruminants, primarily secreted by trophoblastic cells of the blastocyst during early pregnancy (Hernandez *et al.*, 1992) ^[18]. Northey and French (1980) ^[39]

showed that intrauterine infusion of homogenized bovine conceptuses from Days 17 and 18 of gestation prolonged the inter-oestrus interval by inhibiting corpus luteum (CL) regression. Their findings led to the conclusion that, between Days 15 and 17 of pregnancy, the bovine conceptus produces a luteoprotective signal-now known as interferon-tau (IFNT)-which is crucial for sustaining CL function and supporting early pregnancy.

Further research using embryo removal and transfer techniques established that ovine embryos influence the luteal lifespan as early as day 13 after mating (Moor & Rowson, 1966) [35]. Rowson and Moor (1967) [45] demonstrated that homogenates of Day 13 and 14 ovine conceptuses contained substances capable of prolonging the luteal lifespan in nonpregnant ewes. Similarly, Martal *et al.* (1990) [29] showed that homogenates of conceptuses between 14 and 16 days could extend the CL lifespan for over a month when injected into the uteri of cyclic ewes, further supporting the role of conceptus-derived factors in luteal maintenance. In cattle, Northey and French (1980) [39] found that removal of the conceptus at Days 17, 18, or 19 of pregnancy resulted in prolonged luteal lifespans, compared to nonbred controls or conceptus removal at earlier days (13 or 15) of pregnancy. Research involving IFNT infusion into the uterus has further confirmed its role in extending the luteal lifespan. Twice-daily infusions or injections of IFNT (Vallet *et al.*, 1988) [63] or recombinant ovine IFNT (Martal *et al.*, 1990) [29] into the uterus of sheep for 2-8 days extended the luteal lifespan to 22-27 days post-estrus. Similarly, uterine vein infusion of recombinant ovine IFNT (roIFNT) has been shown to extend the luteal lifespan in ewes (Bott *et al.*, 2010) [7], underscoring the critical role of IFNT in pregnancy maintenance.

This secretion continues as the blastocyst elongates (Nephew *et al.*, 1991) [37]. IFNT is the key signaling molecule from the fetus that signals its presence to the mother, preventing luteal regression and supporting the corpus luteum (CL) function, thereby sustaining pregnancy. Upon secretion, IFNT interacts with its receptors on the uterine endometrium, modulating the production of Prostaglandin F_{2α} (PGF_{2α}), a critical mediator of luteal regression (Vallet *et al.*, 1988; Spencer and Bazer, 1996) [63, 57]. This action inhibits PGF_{2α} synthesis, ensuring that the corpus luteum is maintained and progesterone production continues to support pregnancy.

Studies have shown a positive correlation between the levels of Interferon Stimulated Genes (ISG15, MX2) mRNA and the quantity of IFNT administered (Matsuyama *et al.*, 2012) [30]. These studies, which involved uterine infusion of varying amounts of IFNT (0, 500, or 1000 µg), demonstrated that the amount of IFNT infused into the uterine horn ipsilateral to the CL at 16 or 17 days after estrus was correlated with the expression of these genes, confirming the role of IFNT in the regulation of luteal lifespan. In a recent study finding indicate if interferon directly delivered in the CL, then CL has an additional antiluteolytic effect on the endometrium (Guzeloglu *et al.*, 2024) [16].

These findings highlight the importance of IFNT in the regulation of the luteal phase and maternal recognition of pregnancy in ruminants. The ability to manipulate IFNT levels or its signaling pathway holds potential for improving reproductive efficiency in livestock.

Conclusion

In conclusion, enhancing reproductive efficiency in cattle requires a multifaceted approach involving hormonal interventions (GnRH, HCG, Progesterone), NSAIDs, dietary supplementation with omega-3 PUFAs, and understanding of key molecular signals like interferon tau (IFNT). These strategies help improve conception rates, support corpus luteum function, and reduce early embryonic losses. However, variability in outcomes emphasizes the need for developing the suitable protocols based on species, physiological status, and management conditions.

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References

1. Ababneh MM, Alnimer MA, Mustafa QH. Effect of post-insemination progesterone supplement on pregnancy rates of repeat breeder Friesian cows. *Asian-Australasian Journal of Animal Sciences*. 2007;20(11):1670-1676.
2. Aguiar TS, Araújo CV, Tirloni RR, Martins LR. Effect of meloxicam on pregnancy rate of recipient heifers following transfer of *in vitro* produced embryos. *Reproduction in Domestic Animals*. 2013;48(6):984-988.
3. Akhtar P, Rajoriya JS, Singh A, Ojha B. K, Jha AK, Bisen AK, *et al.* Effects of dietary supplementation with omega-3 fatty acid-rich linseed on the reproductive performance of ewes in subtropical climates. *Frontiers in Veterinary Science*. 2024;11:139896. doi:10.3389/fvets.2024.139896.
4. Alkan H, Satılmış F, Yeşilkaya OM, Çiftçi MF, Karakaş S, Alkan K, *et al.* The effect of carprofen treatment on conception rate after insemination in cows with increased days in milk. *Kocatepe Veterinary Journal*. 2021;24(4):1308-1595.
5. Awastii MK, Tiwari RP, Mishra OP. Effect of progesterone supplementation during mid-luteal phase on conception in repeat breeder crossbred cows. *The Indian Journal of Animal Reproduction*. 2002;23(1):67-68.
6. Binelli M, Thatcher WW, Matto R, Baruselli PS. Antiluteolytic strategies to improve fertility in cattle. *Theriogenology*. 2021;56:1451-1463.
7. Bott RC, Ashley RL, Henkes RL, Antoniazzi AQ, Bruemmer JE, Niswender GD, *et al.* Uterine vein infusion of interferon tau (IFNT) extends luteal life span in ewes. *Biology of Reproduction*. 2010;82(4):725-735. doi:10.1095/biolreprod.109.079467.
8. Damarany AI, Ghanem N. Effect of flunixin meglumine and aspirin administration on conception rate and estrous cycle characteristics of Egyptian Baladi cows during hot season. *Tropical Animal Health and Production*. 2020;52:2969-2976.
9. Diskin MG, Sreenan JM. Fertilization and embryonic mortality rates in beef heifers after artificial inversion. *Journal of Reproduction and Fertility*. 1980;59:463-468. doi:10.1530/jrf.0.0590463.
10. Farin CE, Moeller CL, Mayan H, Gambon F, Sawyer HR, Niswender GD. Effects of luteinizing hormone and human chorionic gonadotropin on cell populations in

- the ovine corpus luteum. *Biology of Reproduction*. 1988;38:413-421.
11. Friedman E, Roth Z, Voet H, Lavon Y, Wolfenson D. Hormonal and cellular mechanisms related to conception rates in lactating dairy cows. *Journal of Dairy Science*. 2012;95:3092-3099.
 12. Girgo UG, Kimothi SS, Kumaresan A. Influence of omega-3 rich fatty acid enriched feed on biochemical markers and postpartum reproduction. *Indian Journal of Animal Sciences*. 2020;90(8):1102-1107.
 13. Giordano JO, Fricke PM, Guenther JN, Lopes G Jr, Herlihy MM, Nascimento AB, *et al.* Effect of progesterone on magnitude of the luteinizing hormone surge induced by two different doses of gonadotropin-releasing hormone in lactating dairy cows. *Journal of Dairy Science*. 2012;95:3781-3793.
 14. Guillomot M. Cellular interactions during implantation in domestic ruminants. *Journal of Reproduction and Fertility Supplement*. 1995;49:39-51.
 15. Gulliver CE, Friend MA, King BJ, Clayton EH. The role of omega-3 polyunsaturated fatty acids in reproduction of sheep and cattle. *Animal Reproduction Science*. 2012;131(1-2):9-22. doi:10.1016/j.anireprosci.2012.02.002.
 16. Guzeloglu A, Bishop JV, Campen HV, Plewes MR, Gonzalez-Berrios CL, Kincade NK, *et al.* Interferon-tau infusion into the ovine corpus luteum delays luteolysis. *Biology of Reproduction*. 2024;111(3):667-677.
 17. Henderson KM. Gonadotrophic regulation of ovarian activity. *British Medical Bulletin*. 1979;35:161-166.
 18. Hernandez JJ, Sikes JD, Murphy CN, Watson AJ, Schultz GA, Roberts RM. Expression of bovine trophoblast interferon in conceptuses derived by *in vitro* techniques. *Biology of Reproduction*. 1992;47(3):374-380. doi:10.1095/biolreprod47.3.374.
 19. Howard JM, Manzo R, Dalton JC, Frago F, Ahmadzadeh A. Conception rates and serum progesterone concentration in dairy cattle administered gonadotropin-releasing hormone 5 days after artificial insemination. *Animal Reproduction Science*. 2006;95(3-4):224-233.
 20. Ishida N, Okada M, Sebata K, Minato M, Fukui Y. Effects of GnRH and hCG treatments for enhancing corpus luteum function to increase lambing rate of ewes artificially inseminated during the non-breeding season. *Journal of Reproduction and Development*. 1999;45(1):73-79.
 21. Karsavuranoglu E, Saribay MK, Urer EK. The effects of GnRH and hCG administration on pregnancy rate in postpartum dairy cows. *Livestock Studies*. 2022;62(2):74-80.
 22. Kasimanickam RK, Hall JB, Estill CT, Kastelic JP, Joseph C, Abdel Aziz RL, *et al.* Flunixin meglumine improves pregnancy rate in embryo recipient beef cows with an excitable temperament. *Theriogenology*. 2018;107:70-77. doi:10.1016/j.theriogenology.2018.10.043.
 23. Kumar P, Singh M, Kumar N, Kumar A. Effect of progesterone supplementation on conception rate following single and double insemination in repeat breeder cows. *Indian Journal of Animal Sciences*. 2012;82(8):856-858.
 24. Kumar R, Phogat JB, Sharma RK, Phulia SK, Andonissamy J. Effects of exogenous supplementation of progesterone on conception rates in lactating Murrah buffaloes. *Veterinary Sciences*. 2025;12:261.
 25. Lim-Joo H, Lee JH, Kim HJ, Kim MS, Kim TI, Park SB. Effect of human chorionic gonadotrophin injection after artificial insemination on pregnancy establishment in dairy cattle. *Journal of Embryo Transfer*. 2018;33(3):149-157.
 26. Mahla AS, Chaudhary R, Verma AK, Singh AK, Singh SK, Singh G, *et al.* Effect of dietary supplementation of omega-3 polyunsaturated fatty acid (PUFA) rich fish oil on reproductive performance of the goat (*Capra hircus*). *Theriogenology*. 2017;99:79-89.
 27. Mahla AS, Verma AK, Chaudhary R, Singh SK, Narayanan K, Singh AK, *et al.* Dietary n-3 polyunsaturated fatty acid affects the onset of prostaglandin F₂ α -induced oestrus in the goat (*Capra hircus*). *Journal of Animal Research*. 2016;6(5):801-807.
 28. Maithani M, Prasad S, Kumar S, Malik A. Effect of tolafenamic acid on conception rate following embryo transfer in cattle. *Indian Veterinary Journal*. 2023;100(1):20-25.
 29. Martal J, Degryse E, Charpigny G, Assal N, Reinaud P, Charlier M, *et al.* Evidence for extended maintenance of the corpus luteum by uterine infusion of a recombinant trophoblast alpha-interferon (trophoblastin) in sheep. *Journal of Endocrinology*. 1990;127:R5-R8. doi:10.1677/joe.0.127R005.
 30. Matsuyama S, Kojima T, Kato S, Kimura K. Relationship between quantity of IFNT estimated by IFN-stimulated gene expression in peripheral blood mononuclear cells and bovine embryonic mortality after AI or ET. *Reproductive Biology and Endocrinology*. 2012;10:21. doi:10.1186/1477-7827-10-21.
 31. Merrill ML, Ansotegui RP, Burns PD, MacNeil MD, Geary TW. Effects of flunixin meglumine and transportation on establishment of pregnancy in beef cows. *Journal of Animal Science*. 2007;85:1547-1554.
 32. Miura R, Matsumoto N, Izumi T, Kayano M, Haneda S, *et al.* Effects of human chorionic gonadotropin treatment after artificial inseminations on conception rate with the first follicular wave dominant follicle in the ovary ipsilateral to the corpus luteum in lactating dairy cows. *Journal of Reproduction and Development*. 2018;64(6):501-506.
 33. Modaresi J, Kadivar A, Esfandabadi NS, Khosravian P, Mohebbi A. Evaluation of the effect of sustained-release progesterone injection on the expression of interferon-related genes in repeat-breeder dairy cows. *Veterinary Medicine and Science*. 2024;10:e70005.
 34. Mohammed AE-N, Mohammed MA-S, Ahmed E-W, Shaheen TA-S. Effects of dietary omega-3 fatty acids on reproductive performance and biochemical parameters of lactating cows in arid subtropics. *Pakistan Journal of Zoology*. 2024;56(1):115-122. doi:10.17582/journal.pjz/20231225161301.
 35. Moor RM, Rowson LE. Local maintenance of the corpus luteum in sheep with embryos transferred to various isolated portions of the uterus. *Journal of Reproduction and Fertility*. 1966;12:539-550. doi:10.1530/jrf.0.0120539.
 36. Nazir G, Ghuman SPS, Singh J, Honparkhe M, Ahuja CS, Dhaliwal GS, *et al.* Improvement of conception rate in postpartum flaxseed supplemented buffalo with

- Ovsynch + CIDR protocol. *Animal Reproduction Science*. 2013;137:15-22.
37. Nephew KP, McClure KE, Ott TL, Dubois DH, Bazer FW, Pope WF. Relationship between variation in conceptus development and differences in estrous cycle duration in ewes. *Biology of Reproduction*. 1991;44:536-539. doi:10.1095/biolreprod44.3.536.
 38. Niswender GD, Reimers JJ, Diekmann MA, Nett TM. Blood flow: A mediator of ovarian function. *Biology of Reproduction*. 14:64-81.
 39. Northey DL, French LR. Effect of embryo removal and intrauterine infusion of embryonic homogenates on the lifespan of the bovine corpus luteum. *Journal of Animal Science*. 1980;50:298-302. doi:10.2527/jas1980.502298x.
 40. Parikh SS, Makwana RB, Savaliya BD, Patbandha TK, Murthy KS. Effect of hormonal therapy on fertility in repeat breeding Gir cows. *International Journal of Current Microbiology and Applied Sciences*. 2018;7:4952-4958.
 41. Pereira G, Simões P, Bexiga R, Silva E, Mateus L, Fernandes T, *et al.* Effects of feeding rumen-protected linseed fat to postpartum dairy cows on plasma n-3 polyunsaturated fatty acid concentrations and metabolic and reproductive parameters. *Journal of Dairy Science*. 2021;105:361-374.
 42. Press Information Bureau, Government of India. Department of Animal Husbandry & Dairying releases 20th Livestock Census; Total livestock population increases 4.6% over Census-2012, increases to 535.78 million. New Delhi: Ministry of Fisheries, Animal Husbandry and Dairying; 2019 Oct 16.
 43. Rahman MA, Madyawati SP, Widodo OS, Srianoto P, Sardjito T, Rimayanti. Therapy of human chorionic gonadotropin (hCG) hormone in dairy cattle that have repeat breeder on pregnancy rate in Tulungagung, East Java, Indonesia. *Indian Journal of Forensic Medicine & Toxicology*. 2021;15(4):1238-1243.
 44. Rajkumar R, Singh SK, Agarwal S. K, Mahmood S, Shankar U. Effect of selective COX-2 inhibitor on conception rate, progesterone and PGFM profile in buffalo (*Bubalus bubalis*). *Journal of Applied Animal Research*. 2010;38(2):209-212.
 45. Rowson LEA, Moor RM. Influence of embryonic tissue homogenate infused into uterus on life-span of corpus luteum in sheep. *Journal of Reproduction and Fertility*. 1967;13:511-516.
 46. Santos JEP, Thatcher WW, Chebel RC, Cerri RLA, Galvao KN. The effect of embryonic death rates in cattle on the efficacy of estrus synchronization programs. *Animal Reproduction Science*. 2004;82-83:513-535. doi:10.1016/j.anireprosci.2004.04.015.
 47. Santos JEP, Thatcher WW, Pool L, Overton MW. Effect of human chorionic gonadotropin on luteal function and reproductive performance of high-producing lactating Holstein dairy cows. *Journal of Animal Science*. 2001;79(11):2881-2894.
 48. Sartori R, Sartor-Bergfelt R, Mertens SA, Guenther JN, Parrish JJ, Wiltbank MC. Fertilization and early embryonic development in heifers and lactating cows in summer and lactating and dry cows in winter. *Journal of Dairy Science*. 2002;85:2803-2812. doi:10.3168/jds.S0022-0302(02)74367-1.
 49. Scenna FM, Hockett ME, Towns TM, Saxton AM, Rohrbach NR, Wehrman FN, *et al.* Influence of a prostaglandin synthesis inhibitor administered at embryo transfer on pregnancy rates of recipient cows. *Prostaglandins & Other Lipid Mediators*. 2005;78(1):38-45.
 50. Schlapp G, Goyeneche L, Fernandez G, Menchaca A, Crispo M. Administration of the nonsteroidal anti-inflammatory drug tolfenamic acid at embryo transfer improves maintenance of pregnancy and embryo survival in recipient mice. *Journal of Assisted Reproduction and Genetics*. 2015;32:271-275.
 51. Schmitt ÉJP, Barros CM, Fields PA, Fields MJ, Diaz T, Kluge JM, *et al.* A cellular and endocrine characterization of the original and induced corpus luteum after administration of a gonadotropin-releasing hormone agonist or human chorionic gonadotropin on day five of the estrous cycle. *Journal of Animal Science*. 1996;74(8):1915-1929.
 52. Singh J, Kasrija R, Dhaliwal GS, Gandotra VK, Honparkhe M. Effect of post-insemination progesterone supplementation on conception rate in repeat breeding cattle. *Indian Journal of Animal Sciences*. 2008;78(3):281-282.
 53. Singh SP, Kumar A, Bhavsar P, Bhavsar M, Sourya N, Singh AK, *et al.* Application of non-steroidal anti-inflammatory drugs (NSAIDs) for improvement of cattle fertility. *The Pharma Innovation Journal*. 2021;10:404-407.
 54. Singh SP, Kumar A, Bhavsar PP, Sahu M, Kumar P, Kumar S. Evaluation of the effect of GnRH analogue, progesterone and tolfenamic acid on serum progesterone profile and conception rate in repeat breeding crossbred cattle. *International Journal of Current Microbiology and Applied Sciences*. 2020;9:2630-2637.
 55. Skidmore JA, Billah M, Allen WR. Investigation of factors affecting pregnancy rate after embryo transfer in the dromedary camel. *Reproduction, Fertility and Development*. 2002;14:109-116.
 56. Spencer JA, Konetchy D, Ahmadzadeh A. Influences of non-steroidal anti-inflammatory drugs on dairy cattle reproductive performance. *Applied Animal Science*. 2020;36:397-406.
 57. Spencer TE, Bazer FW. Ovine interferon tau suppresses transcription of the estrogen receptor and oxytocin receptor genes in the ovine endometrium. *Endocrinology*. 1996;137(3):1144-1147.
 58. Spencer TE, Johnson GA, Bazer FW, Burghardt RC, Palmarini M. Pregnancy recognition and conceptus implantation in domestic ruminants: Roles of progesterone, interferons and endogenous retroviruses. *Reproduction, Fertility and Development*. 2007;19:65-78. doi:10.1071/RD06102.
 59. Sreenan JM, Diskin MG, Morris DG. Embryo survival in cattle: A major limitation to the achievement of high fertility. *BSAP Occasional Publication*. 2001;26:93-104. doi:10.1017/S0263967X00033619.
 60. Stevenson JS, Portaluppi MA, Tenhouse DE, Lloyd A, Eborn DR, Kacuba S, *et al.* Interventions after artificial insemination: Conception rates, pregnancy survival, and ovarian responses to gonadotropin-releasing hormone, human chorionic gonadotropin, and progesterone. *Journal of Dairy Science*. 2007;90(1):331-340.

61. Thakur T, Singh M, Kumar P, Sharma A. Efficacy of human chorionic gonadotropin administration during luteal phase in dairy cows on progesterone concentration and conception rate. *Haryana Veterinarian*. 2018;57(2):194-197.
62. Thatcher WW, Staples CR, Danet-Desnoyers G, Oldick B, Schmitt E. P. Embryo health and mortality in sheep and cattle. *Journal of Animal Science*. 1994;72(Suppl_3):16-30. doi:10.2527/1994.72suppl_316x.
63. Vallet JL, Bazer FW, Fliss MF, Thatcher WW. Effect of ovine conceptus secretory proteins and purified ovine trophoblast protein-1 on interoestrous interval and plasma concentrations of prostaglandins F-2 alpha and E and of 13,14-dihydro-15-keto prostaglandin F-2 alpha in cyclic ewes. *Journal of Reproduction and Fertility*. 1988;84:493-504. doi:10.1530/jrf.0.0840493.
64. Verma AK, Mahla AS, Chaudhari R, Singh SK, Singh AK, Narayanan K, *et al.* Effect of n-3 polyunsaturated fatty acid rich fish oil supplementation on serum biochemical profile in goat. *Indian Journal of Animal Sciences*. 2017;87(5):619-623.
65. Verma AK, Mahla AS, Chaudhari R, Singh AS, Khattia A, Singh SK, *et al.* Effect of different levels of n-3 polyunsaturated fatty acids rich fish oil supplementation on the ovarian and endometrial functions in the goat (*Capra hircus*). *Animal Reproduction Science*. 2018;195:153-161.

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