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Factors Affecting Ovum Pick-Up (OPU) in Friesian Cattle: A Review

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Abstract: Ovum pick-up (OPU) combined with in vitro embryo production (IVEP) has become an important reproductive biotechnology in dairy cattle breeding programs. The technique allows repeated recovery of oocytes from valuable donor animals, thereby accelerating genetic improvement and increasing reproductive efficiency. Friesian cattle, owing to their high milk-producing potential, are extensively utilized in OPU programs worldwide. However, the success of OPU depends on several biological, environmental, nutritional, hormonal, and technical factors that influence follicular development, oocyte quality, and embryo production. This review summarizes the major factors affecting OPU efficiency in Friesian cattle, including age, genetic background, nutrition, hormonal stimulation, follicular dynamics, heat stress, health status, operator expertise, and management practices. Understanding these factors is essential for optimizing oocyte recovery and improving the outcomes of assisted reproductive technologies in dairy herds.

Keywords: Ovum pick-up, Friesian cattle, oocyte competence, embryo production, follicular dynamics, reproductive biotechnology.

INTRODUCTION

Ovum pick-up (OPU) is an ultrasound-guided transvaginal technique used to aspirate oocytes from ovarian follicles in live animals. Since its introduction in cattle during the 1990s, OPU has revolutionized embryo production systems and has become an indispensable tool in modern breeding programs (Pieterse et al., 1988). The integration of OPU with in vitro fertilization (IVF) and embryo transfer technologies allows rapid multiplication of genetically superior animals. Friesian cattle, especially Holstein-Friesians, represent one of the most productive dairy breeds worldwide. Their superior milk yield makes them attractive candidates for reproductive biotechnologies aimed at enhancing genetic progress. Nevertheless, considerable variability exists among donors regarding oocyte yield, developmental competence, and embryo production.

The efficiency of ovum pick-up (OPU) programs is generally evaluated using several reproductive and embryological parameters that reflect the success of oocyte retrieval and subsequent embryo production. These parameters include the number of follicles aspirated and the number of oocytes recovered during each OPU session, which provide an indication of ovarian response and recovery efficiency (Pieterse et al., 1988; Merton et al., 2003). Additional indicators, such as the recovery rate and the percentage of viable oocytes, are used to assess the quality and developmental potential of the collected oocytes (Pontes et al., 2011). Following in vitro fertilization, cleavage rate and blastocyst production serve as

important measures of embryo development and competence (Lonergan et al., 2016). Ultimately, the overall success of OPU programs is determined by pregnancy rates after embryo transfer, as this parameter reflects the ability of the recovered oocytes to develop into viable embryos capable of establishing and maintaining pregnancy (Watanabe et al., 2017).

Numerous factors influence these outcomes, ranging from intrinsic animal characteristics to environmental and technical conditions.

BREED AND GENETIC FACTORS

Genetic background significantly influences ovarian function and OPU performance. Friesian cattle generally exhibit lower follicular populations than Bos indicus breeds, resulting in lower oocyte recovery rates.

Studies have shown considerable variation among Friesian donors in:

- Antral follicle count (AFC).
- Oocyte quality.
- Embryo production.
- Hormonal profiles.

Animals possessing higher AFC usually yield more oocytes and embryos. Genomic selection has increasingly focused on reproductive traits to identify elite donors suitable for OPU programs.

Moreover, genetic merit for milk production may negatively correlate with fertility traits. High-producing Friesian cows often experience metabolic stress, affecting ovarian activity and oocyte competence.

AGE OF THE DONOR ANIMAL

Age is one of the most critical determinants of OPU success.

Young Heifers

Prepubertal Friesian heifers possess a large follicular reserve and can produce numerous oocytes. However, these oocytes frequently demonstrate reduced developmental competence because of incomplete cytoplasmic maturation.

Mature Cows

Adult Friesian cows generally provide:

- Better-quality oocytes.
- Higher blastocyst rates.
- Improved pregnancy outcomes.

Older Cows

Advanced age is associated with:

- Reduced ovarian reserve.
- Increased follicular atresia.
- Declining oocyte competence.
- Lower embryo production.

Research indicates that cows between three and seven years of age usually exhibit optimal OPU performance.

NUTRITIONAL STATUS AND ENERGY BALANCE

Nutrition plays a fundamental role in regulating folliculogenesis and reproductive performance in dairy cattle and is therefore a major determinant of the success of ovum pick-up (OPU) programs in Friesian cows. High-producing Friesian cattle frequently experience negative energy balance during early lactation because the energy required for milk production exceeds dietary energy intake. This metabolic imbalance leads to reduced circulating concentrations of insulin and insulin-like growth factor-1 (IGF-1), both of which are essential for normal ovarian function and follicular development. Consequently, negative energy balance can delay follicular growth, impair oocyte maturation, reduce oocyte quality, and compromise embryo survival. These metabolic disturbances adversely affect the developmental competence of oocytes and ultimately decrease the efficiency of in vitro embryo production.

Body condition score (BCS) is another important indicator of the nutritional and reproductive status of donor animals. An optimal BCS ranging from 3.0 to 3.5 on a five-point scale is generally associated with superior OPU outcomes, including improved follicular activity, higher oocyte recovery rates, and better embryo production. In contrast, both underconditioned and obese cows may exhibit reduced reproductive efficiency due to hormonal imbalances and altered metabolic function. Furthermore, adequate intake of essential micronutrients is critical for maintaining normal ovarian physiology. Deficiencies of minerals and vitamins such as selenium, zinc, copper, vitamin A, and vitamin E may impair follicular development, reduce oocyte competence, and negatively affect embryo quality. In recent years, dietary supplementation with antioxidants has gained considerable attention because of its ability to reduce oxidative stress, protect reproductive tissues, and improve embryo production. Therefore, appropriate nutritional management is essential for optimizing reproductive performance and maximizing the success of OPU programs in Friesian cattle.

HORMONAL STIMULATION PRIOR TO OPU

Hormonal stimulation is routinely employed in ovum pick-up (OPU) programs to maximize follicular recruitment and improve both the quantity and quality of oocytes recovered from donor Friesian cattle. The primary objective of hormonal treatment is to stimulate the growth of a greater number of recruitable follicles and to synchronize follicular

development, thereby enhancing the efficiency of in vitro embryo production. Among the various hormonal protocols, follicle-stimulating hormone (FSH) is the most widely used gonadotropin for ovarian superstimulation. Administration of FSH before OPU increases the number of medium-sized follicles available for aspiration, improves oocyte competence, and enhances subsequent cleavage and blastocyst production rates. Superstimulation protocols generally consist of multiple FSH injections administered over a period of two to four days before follicular aspiration, allowing the simultaneous development of numerous follicles and increasing the probability of recovering developmentally competent oocytes.

Gonadotropin-releasing hormone (GnRH) also plays an important role in OPU programs by regulating the release of luteinizing hormone (LH) and FSH from the anterior pituitary gland. The administration of GnRH promotes ovulation or luteinization of dominant follicles and facilitates the synchronization of follicular waves, enabling more precise scheduling of OPU sessions. Synchronization protocols using GnRH are particularly useful in reducing variability in ovarian responses among donor animals and improving the consistency of oocyte recovery. Another hormone frequently used in reproductive biotechnologies is equine chorionic gonadotropin (eCG), which possesses both FSH- and LH-like activities. Treatment with eCG can stimulate follicular growth and increase the number of aspiratable follicles; however, prolonged hormonal activity may lead to persistent follicular dominance and negatively affect oocyte quality and developmental competence. Consequently, the use of eCG requires careful consideration and optimization.

The effectiveness of hormonal stimulation protocols varies considerably among individual animals and is influenced by several factors, including the age of the donor, lactation status, nutritional condition, reproductive health, and the frequency of OPU sessions. Young heifers, lactating cows, and animals subjected to repeated OPU procedures may respond differently to hormonal treatments. Therefore, selecting an appropriate hormonal protocol tailored to the physiological and reproductive status of each donor is essential for maximizing oocyte recovery, improving embryo production, and increasing the overall success of OPU programs in Friesian cattle.

FOLLICULAR DYNAMICS AND ANTRAL FOLLICLE COUNT

Follicular wave dynamics strongly influence oocyte recovery.

Friesian cows typically exhibit two or three follicular waves during an estrous cycle. The stage of the follicular wave at the time of OPU affects:

- Number of aspiratable follicles.
- Oocyte competence.
- Embryo production.

Follicle Size Categories

Follicles are classified as:

- Small: 2–5 mm.
- Medium: 6–9 mm.

- Large: >9 mm.

Medium-sized follicles generally yield oocytes with the greatest developmental competence.

Antral Follicle Count (AFC)

AFC is increasingly recognized as an important predictor of OPU performance. High-AFC cows exhibit:

- Increased oocyte recovery.
- Greater blastocyst production.
- Better reproductive efficiency.

Repeated OPU sessions can alter follicular dynamics and influence subsequent ovarian responses.

HEAT STRESS AND ENVIRONMENTAL FACTORS

Heat stress is a major challenge affecting reproductive performance in Friesian cattle, particularly in tropical and subtropical regions. High ambient temperatures can lead to elevated cortisol concentrations, reduced feed intake, increased oxidative stress, and various hormonal disturbances, all of which negatively influence ovarian function. Consequently, heat stress impairs follicular growth, oocyte maturation, fertilization, and embryo development, ultimately reducing the efficiency of ovum pick-up (OPU) and embryo production programs. Temperatures exceeding 25–27°C, especially when accompanied by high humidity, have been shown to adversely affect reproductive performance in dairy cattle. To minimize these negative effects, several management strategies can be employed, including the use of fans and sprinklers, provision of shade systems and cooling facilities, and appropriate nutritional adjustments. Studies have demonstrated that severe heat stress may reduce embryo production by as much as 40%, highlighting the importance of effective heat-abatement measures in Friesian herds.

HEALTH AND REPRODUCTIVE STATUS

The reproductive and health status of donor cows plays a crucial role in determining the efficiency of ovum pick-up (OPU) and subsequent embryo production. Various health disorders, including endometritis, metritis, mastitis, lameness, and metabolic diseases, are associated with poor OPU outcomes due to their detrimental effects on ovarian function and oocyte quality. Even subclinical inflammation can adversely affect reproductive performance by altering hormonal secretion, reducing ovarian blood flow, and impairing follicular development. Therefore, donor cows selected for OPU should be clinically healthy, exhibit normal estrous cyclicity, and be free from reproductive disorders to ensure optimal oocyte recovery and developmental competence. Additionally, the postpartum interval is an important consideration, as cows subjected to OPU too soon after calving often experience reduced reproductive performance because of incomplete uterine recovery and the negative energy balance commonly observed during early lactation.

FREQUENCY OF OPU SESSIONS

The interval between ovum pick-up (OPU) sessions significantly affects ovarian response and the overall efficiency of embryo production programs in Friesian cattle. Common OPU schedules include twice-weekly, weekly, and biweekly sessions, each having different effects on follicular development and oocyte recovery. Frequent OPU sessions offer several advantages, such as increasing the total number of oocytes recovered and enhancing annual embryo production. However, excessive aspiration may also have negative consequences, including ovarian trauma, increased follicular degeneration, and a reduction in oocyte quality. Therefore, determining an optimal interval between OPU sessions is essential to maximize oocyte yield while maintaining ovarian health and reproductive performance.

TECHNICAL FACTORS AND OPERATOR SKILL

Technical expertise is one of the most important determinants of the success of ovum pick-up (OPU) programs in cattle. Several technical factors influence the efficiency of oocyte recovery and subsequent embryo production, including ultrasound image quality, needle size, vacuum pressure, aspiration speed, collection medium, and proper handling of oocytes. Among these factors, vacuum pressure plays a crucial role in determining oocyte quality and recovery rates. Excessive vacuum pressure can damage the cumulus cells surrounding the oocyte and reduce oocyte viability, whereas insufficient vacuum pressure may lower the overall recovery rate. In addition, the experience and skill of the operator significantly affect OPU outcomes. Experienced operators generally achieve higher oocyte recovery rates, minimize ovarian damage, and obtain better-quality oocytes compared with less experienced personnel. Therefore, adequate training and the implementation of standardized protocols are essential for maximizing the efficiency and success of OPU procedures in Friesian cattle.

SEASONAL VARIATION

Seasonal variations significantly influence ovarian activity and reproductive performance in Friesian cattle. Environmental conditions during the summer season often have adverse effects on reproductive efficiency, leading to reduced follicular development, decreased oocyte competence, and lower embryo production rates. In contrast, winter and moderate climatic conditions generally favor better ovarian function and improved outcomes of ovum pick-up and embryo production programs. Factors such as photoperiod, humidity, and ambient temperature interact with endocrine pathways, affecting hormonal balance and follicular dynamics. Consequently, seasonal fluctuations play an important role in determining the success of reproductive technologies in Friesian cattle.

OOCYTE QUALITY ASSESSMENT

The developmental competence of oocytes remains a major determinant of IVEP success.

Oocytes are commonly graded according to:

Grade I

- Compact cumulus layers.
- Homogeneous cytoplasm.

Grade II

- Partial cumulus investment.

Grade III

- Irregular cytoplasm.

Grade IV

- Degenerated oocytes.

Only high-quality oocytes consistently produce transferable embryos.

Factors affecting oocyte quality include:

- Nutrition.
- Hormones.
- Heat stress.
- Follicular size.
- Age.

FUTURE PERSPECTIVES

Recent advances in ovum pick-up (OPU) technology have significantly improved the efficiency of reproductive programs in dairy cattle. Modern developments include the use of genomic selection for identifying superior donor animals, automated systems for monitoring follicular growth, optimization of hormonal stimulation protocols, and the identification of biomarkers associated with oocyte competence. In addition, artificial intelligence-assisted embryo selection has emerged as a promising tool for improving the accuracy of embryo evaluation and increasing pregnancy success rates. Despite these advancements, further research is required to optimize OPU protocols specifically for Friesian cattle reared under diverse climatic and management conditions, thereby maximizing reproductive performance and genetic progress.

CONCLUSION

The efficiency of ovum pick-up in Friesian cattle is influenced by a complex interaction of animal, environmental, nutritional, hormonal, and technical factors. Age, genetic background, energy balance, hormonal stimulation, follicular dynamics, heat stress, health

status, and operator expertise significantly affect oocyte recovery and embryo production. Optimizing these factors can substantially improve reproductive performance and accelerate genetic progress in dairy herds. Continued research focusing on donor selection, nutritional strategies, and advanced reproductive technologies will further enhance the success of OPU programs in Friesian cattle.

REFERENCES

Boni, R. (2012). Heat stress, a serious threat to reproductive efficiency in dairy cattle. *Animal Frontiers*, 2(1), 6–11.

Bó, G. A., Mapletoft, R. J., & Adams, G. P. (2018). Ovarian stimulation protocols in cattle. *Theriogenology*, 112, 3–16.

Chaubal, S. A., Ferre, L. B., Molina, J. A., Faber, D. C., Bols, P. E., Rezamand, P., Tian, X., & Yang, X. (2006). Hormonal treatments for increasing oocyte competence in cattle. *Theriogenology*, 65(1), 191–199.

De Roover, R., Bols, P. E., Genicot, G., Hanzen, C., & Dessy, F. (2008). Characterization of bovine follicular dynamics to improve OPU outcomes. *Reproduction in Domestic Animals*, 43, 81–85.

Garnsworthy, P. C., Sinclair, K. D., & Webb, R. (2008). Integration of physiological mechanisms regulating fertility in dairy cows. *Animal*, 2(8), 1144–1152.

Lonergan, P., Fair, T., Forde, N., & Rizos, D. (2016). Embryo development and quality in cattle. *Animal Reproduction*, 13(3), 264–272.

Merton, J. S., de Roos, A. P. W., Mullaart, E., de Ruigh, L., Kaal, L., Vos, P. L., & Dieleman, S. J. (2003). Factors affecting oocyte and embryo production in cattle. *Theriogenology*, 60(4), 651–658.

Pieterse, M. C., Kappen, K. A., Kruip, T. A. M., & Taverne, M. A. M. (1988). Aspiration of bovine oocytes during transvaginal ultrasound scanning. *Theriogenology*, 30(4), 751–762.

Pontes, J. H. F., Melo Sterza, F. A., Basso, A. C., Ferreira, C. R., Sanches, B. V., Rubin, K. C. P., & Seneda, M. M. (2011). Ovum pick-up, in vitro embryo production, and pregnancy rates in dairy cattle. *Theriogenology*, 75(5), 900–906.

Rizos, D., Ward, F., Duffy, P., Boland, M. P., & Lonergan, P. (2002). Consequences of bovine oocyte maturation conditions for embryo development. *Theriogenology*, 58(6), 1241–1251.

Santos, J. E. P., Cerri, R. L. A., & Sartori, R. (2008). Nutritional management and reproduction of dairy cattle. *Theriogenology*, 70(3), 409–419.

Sirard, M. A., Richard, F., Blondin, P., & Robert, C. (2006). Contribution of follicular environment to oocyte competence. *Theriogenology*, 65(1), 119–131.

Snijders, S. E. M., Dillon, P., O'Callaghan, D., & Boland, M. P. (2000). Effect of genetic merit and nutrition on embryo production in dairy cattle. *Theriogenology*, 53(4), 981–994.

Walsh, S. W., Williams, E. J., & Evans, A. C. O. (2011). A review of the causes of poor fertility in high milk-producing dairy cows. *Animal Reproduction Science*, 123(3–4), 127–138.

Watanabe, Y. F., Souza, A. H., Mingoti, R. D., Ferreira, R. M., Batista, E. O., Dayan, A., & Baruselli, P. S. (2017). Number of oocytes retrieved per donor during OPU and its effects on embryo production. *Theriogenology*, 87, 15–21.