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Research Article

Significance of Artificial Insemination over Natural Mating in Poultry and the Risks of Post-Insemination Physical Trauma

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Abstract

Artificial insemination (AI) is a key reproductive technology in modern poultry farming, offering significant advantages over natural mating. It enhances genetic selection, reproductive efficiency, and disease control while minimizing physical interaction between birds, thereby improving biosecurity. AI allows for precise selection of superior traits, optimizing productivity and genetic diversity. However, improper techniques and frequent insemination can lead to physical trauma, reproductive organ injuries, and stress in hens, which may impact welfare and productivity. Ensuring best practices in AI, such as trained personnel, hygienic procedures, and appropriate insemination frequency, is critical to mitigating these risks. This paper explores the benefits of AI in poultry production, emphasizing its role in genetic improvement, biosecurity, and reproductive efficiency. Additionally, it assesses potential risks, particularly post-insemination trauma, and discusses mitigation strategies to enhance animal welfare. The study highlights AI's role in overcoming natural mating limitations, including size incompatibilities and reduced fertility in aging breeder males. Despite its advantages, AI requires careful management to balance productivity gains with ethical considerations. Addressing these concerns through proper training, ergonomic equipment, and welfare monitoring ensures AI's sustainable application in poultry farming. As AI continues to evolve, integrating welfare-focused practices will be essential to maintaining both productivity and ethical standards in poultry breeding.

Keywords

Animal Welfare, Artificial Insemination (AI), Biosecurity, Genetic Improvement, Reproductive Efficiency

1. Introduction

The global poultry population is estimated at 16.2 billion, with 71.6% of this population located in developing countries, producing 6.7 million tons of chicken meat and 5.8 million tons of hen eggs annually [1]. Poultry farming contributes significantly to economic, social, nutritional, and cultural benefits in developing nations [2]. It provides high-quality animal protein, such as eggs and meat, which are crucial for addressing malnutrition [3, 4]. The growing consumption of chicken products underscores the urgent need to increase production capacity, especially in layer and broiler operations, to meet demand [5].

The success of poultry breeding hinges on several factors, including reproductive traits, testicular and reproductive tract health, and proper rearing practices. Housing systems and mating strategies have emerged as crucial determinants of parent stock performance [6]. Researchers now aim to analyze the impact of these factors on productivity and reproductive outcomes, acknowledging the advantages and disadvantages

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inherent to different systems [7].

Reproductive efficiency in poultry is influenced by seasonal, environmental, and behavioral factors. Fertility and hatchability rates are critical determinants of hatchery profitability [8]. Male-to-female mating ratios, such as 1:14-16 for layers and 1:10-12 for broilers, are recommended for optimal fertility [9]. However, fertility declines with breeder age, primarily due to reduced mating activity in older males [10, 11].

AI presents an innovative alternative to natural mating, allowing for controlled breeding and improved efficiency. This paper explores the advantages of AI in poultry production and assesses the risks associated with post-insemination trauma, emphasizing the necessity of adopting best practices.

2. Significance of Artificial Insemination in Poultry

2.1. Historical Context

AI was first successfully employed in poultry in 1899, when Ivanov used semen extracted from a cock's ductus deferens to produce fertile chicken eggs [12]. In 1936, Quinn and Burrows introduced the widely used intravaginal insemination technique. Unlike mammals, avian sperm remains viable at body temperature, making AI particularly effective in poultry breeding [13].

2.2. Genetic Improvement

Artificial insemination (AI) is pivotal in poultry genetic improvement, offering unparalleled control over breeding programs and enabling rapid dissemination of desirable traits. By allowing the targeted selection of superior males, AI facilitates genetic enhancements across large populations without the constraints of natural mating. This approach enables breeders to focus on improving specific traits, such as egg production, disease resistance, or feed efficiency, leading to higher productivity and profitability. For instance, AI has been used to develop Norfa chickens with enhanced egg production traits through selective breeding, demonstrating its capacity to achieve precise genetic advancements over generations [14]. Furthermore, AI allows for the use of advanced genetic technologies, such as cryopreservation and germplasm banking, which preserve valuable genetic materials for future use. These methods not only improve the breeding process but also contribute to biodiversity conservation and the prevention of genetic erosion [15]. Additionally, AI addresses fertility challenges in species like guinea fowl, where natural mating systems often result in low fertility rates, enabling quicker genetic improvements and scaling up of superior germplasm for commercial purposes [16]. Overall, AI in poultry integrates advanced reproductive technologies to accelerate genetic gains, improve production efficiency, and support sustainable breeding practices.

2.3. Enhanced Biosecurity

AI serves as a key element in poultry biosecurity, minimizing physical contact between male and female birds and reducing the transmission of diseases such as avian influenza and Newcastle disease [17]. Sanitary collection and insemination practices further bolster biosecurity measures, ensuring healthier poultry populations.

2.4. Reproductive Efficiency

AI allows for precise timing of insemination, optimizing fertility rates and increasing hatchability. It reduces the need for a large number of males in breeding flocks, cutting costs and simplifying flock management. AI also facilitates semen transport across geographically dispersed farms, enabling controlled breeding on a larger scale [18].

3. Risks of Post-Insemination Physical Trauma

3.1. Nature of Trauma

Artificial insemination (AI) in poultry can lead to trauma, primarily due to improper handling or the repetitive nature of the process. Physical injuries, such as cloacal abrasions or micro-tears, are common when inexperienced personnel or unsuitable equipment is used. Psychological stress from repeated restraint and handling further exacerbates the issue, as stress hormones like corticosterone are elevated, potentially impairing immune responses and overall productivity [19]. Environmental factors, such as improper lighting during handling, can also contribute to distress. Research indicates that lighting designed for poultry welfare bright but non-flickering, with ultraviolet supplementation can reduce stress and improve the birds' well-being during such procedures [20]. Adhering to animal welfare guidelines, including using trained personnel, appropriate equipment, and minimizing handling frequency, is crucial for mitigating trauma associated with AI.

3.2. Contributing Factors

The primary factors contributing to post-insemination trauma include:

1) Inexperienced Handlers: Lack of training leads to improper semen deposition.
2) Frequent Insemination: Overuse of AI results in cloacal fatigue and tissue damage.
3) Unsterilized Equipment: Inadequate hygiene can lead to infections.
4) Mitigation Strategies.

To minimize risks, the following measures are essential:

1) Training Programs: Certification programs for handlers can reduce trauma by 50% [21].
2) Ergonomic Equipment: Species-specific tools reduce the risk of injury.
3) Welfare Monitoring: Regular assessments for injuries and infections enable early intervention.

4. Comparison Between Artificial Insemination and Natural Mating

4.1. Limitations of Natural Mating

Natural mating in poultry faces several limitations that restrict its efficiency, particularly in commercial and high-production settings. One of the primary challenges is the physical incompatibility between male and female birds, especially in larger breeds like broilers or turkeys, where the size of males can hinder successful mating. This often results in reduced fertility rates and necessitates alternative methods such as artificial insemination to ensure productivity. Additionally, natural mating is constrained by the limited genetic diversity accessible within the flock, as mate selection occurs without human control, restricting the potential for targeted genetic improvement. Over-mating in flocks can also lead to injuries and stress in females, impacting overall health and egg production. Another significant limitation is the lack of precision in lineage tracking, which complicates selective breeding programs aimed at optimizing specific traits such as disease resistance, growth rates, or egg quality. Moreover, natural mating poses biosecurity risks, as close contact among birds increases the chances of disease transmission. These factors have driven the poultry industry to adopt artificial insemination for more effective breeding strategies and genetic advancements [22].

4.2. Advantages of AI

Artificial insemination (AI) offers several advantages in poultry breeding, particularly in optimizing genetic improvement and enhancing production efficiency. AI enables the controlled selection of genetic traits by allowing breeders to use semen from superior males across large populations, thereby overcoming natural mating limitations such as size mismatches or physical disabilities in birds. This method enhances fertility rates by ensuring precise semen placement and reducing wastage. AI also facilitates the use of semen diluents, which can preserve the viability of sperm, extend its usability, and allow transportation over long distances. Moreover, it reduces the risks of injury and stress to hens often associated with natural mating. AI is particularly beneficial in commercial poultry systems where genetic improvement and consistent productivity are paramount. For example, studies show that the use of advanced tools, such as heat-insulation tanks for semen preservation, further improves fertilization outcomes by maintaining semen quality at optimal temperatures during handling and storage [23]. However, for local breeds like Deshi chickens, while AI can achieve high efficiency experimentally, the commercial viability often depends on innovations like semen diluents to reduce costs and enhance practicality [24].

5. Conclusion

Artificial insemination (AI) has indeed transformed poultry production by addressing many of the limitations associated with natural mating, particularly in commercial settings. It enables targeted genetic improvement by allowing breeders to select superior males whose genetic material can be disseminated across a large population. This has led to advancements in traits such as egg production, growth rates, disease resistance, and feed efficiency. Moreover, AI enhances biosecurity by reducing direct physical interaction between birds, thereby mitigating the risk of disease transmission. Additionally, AI optimizes reproductive efficiency, particularly in species where natural mating is problematic, such as turkeys, which are physically unable to mate naturally due to their size.

However, the implementation of AI is not without challenges, particularly regarding the welfare of the birds involved. Post-insemination trauma, including physical injuries like cloacal abrasions or psychological stress due to repeated handling, underscores the need for adherence to best practices. Proper training of handlers is crucial to ensure that the procedure is carried out gently and efficiently. The use of sterilized, ergonomically designed equipment is equally important to minimize physical harm. Welfare monitoring before, during, and after AI procedures can help identify and address issues promptly, ensuring the birds remain healthy and productive.

By focusing on these welfare considerations, the poultry industry can not only enhance productivity but also align with growing consumer expectations for humane treatment of animals. This balance between efficiency and welfare is essential for the sustainable development of AI technologies in poultry farming. Addressing these challenges will enable the full realization of AI's potential while maintaining high ethical standards in animal husbandry.

Abbreviations

IB	Infectious Bronchitis
IBV	Infectious Bronchitis Virus
RT-PCR	Reverse Transcription Polymerase Chain Reaction

Author Contributions

Helen Aklilu is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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