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## Artificial Insemination in Poultry Production: Methods, Advantages, and Challenges

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### Abstract:

Artificial insemination (AI) is a widely adopted reproductive technology that plays a crucial role in modern poultry production. This review outlines the principles, techniques, and applications of AI in poultry, including semen collection, evaluation, preservation, and insemination methods. AI offers several advantages such as efficient utilization of superior males, rapid genetic improvement, reduced need for males, and better control of reproductive diseases. The success of AI largely depends on semen quality, proper handling, and precise insemination techniques. The use of semen extenders and appropriate storage conditions further enhances sperm viability. A unique feature of avian reproduction, the presence of sperm storage tubules, allows prolonged fertility following a single insemination, improving its practical applicability. Additionally, factors affecting semen quality such as genetics, nutrition, management, and environmental conditions are discussed. Overall, AI remains an essential tool for improving productivity, genetic advancement, and biosecurity in poultry farming, making it indispensable for sustainable poultry production.

**Keywords:** Artificial insemination, Poultry, Semen collection, Semen extenders, Vaginal insemination, Sperm storage tubules, Fertility

### Introduction:

Imagine being able to produce more chicks, improve the quality of your flock, and reduce the spread of diseases, all without dramatically increasing the number of male birds you keep. That is exactly what Artificial Insemination (AI) offers the modern poultry farmer. Although the idea may sound complicated, it has been used successfully in poultry farming for nearly a century and is now one of the most important tools in the global poultry industry. Artificial insemination (AI) is the process of collecting semen from a male bird (a cockerel or tom turkey) and placing it directly into the reproductive tract of a female bird. Instead of allowing natural mating, the farmer takes control of the process deciding which male's semen is used and which females receive it (Aisha and Zain, 2010). The very first successful AI in poultry was carried

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out in 1899 by a scientist named Ivanov, who produced fertile chicken eggs using semen collected from a rooster. The technique became practical when Quinn and Burrows developed a safe, non-invasive method for collecting semen in 1936 and 1937 a technique still widely used today (Lunak, 2010; Quinn and Burrows, 1936).

### Why is AI Important for Poultry Farmers:

The poultry industry has grown enormously over recent decades to meet the rising global demand for chicken meat and eggs. With that growth has come a significant challenge: modern broiler breeds have been so heavily selected for fast growth and large body size that natural mating has become difficult or even impossible in some cases (Bramwell, 2002). Large, heavy males struggle to mount females, leading to poor fertility rates.

AI solves this problem by removing the need for direct physical contact between male and female birds. The key benefits include:

- **Efficient Use of Top Quality Males:** One high performing cockerel can fertilize many more hens than would be possible through natural mating. This dramatically reduces the number of males needed, cutting costs (Benoff *et al.*, 1981).
- **Better Genetics:** Farmers can rapidly spread the genes of their best birds across a large flock, accelerating genetic improvement (Vishwanath and Shannon, 1997).
- **Disease Control:** Because birds are not in direct sexual contact, the spread of certain reproductive and venereal diseases is significantly reduced (Foote, 2002).
- **Semen Preservation:** With the right techniques, semen can be stored and even transported to other farms or countries, opening doors for genetic exchange without moving live animals (Benoff *et al.*, 1981).

### AI in Chicken:

#### Collection of Semen from Rooster:

The most widely used method of semen collection from roosters is called the abdominal massage technique, first described by Burrows and Quinn in 1937. It is non-invasive, meaning no surgery is required, and can be performed quickly in a commercial setting.

- The rooster is gently restrained.
- The handler strokes the rooster's back firmly from the wings toward the tail to stimulate him.
- The rooster responds by extending his reproductive organ (the phallus).
- The handler gently squeezes the cloaca (the bird's urogenital opening) to collect the semen into a small container (Burrows and Quinn, 1937).

To ensure the best results, roosters are typically prepared for this process several days in advance and housed separately from hens. Withholding food for 12 hours before collection helps prevent fecal

contamination of the semen sample (Burrows and Quinn, 1937).

### Checking Semen Quality:

Healthy rooster semen is creamy white or milky in color. A semen sample that appears watery may indicate a low sperm count, while a brown or green color could mean contamination from feces (Cole and Cupps, 1977). A single ejaculation produces a small volume typically between 0.2 and 0.5 ml, but it is packed with sperm. A good-quality sample contains between 3,000 and 7,000 million sperm per milliliter (Hafez and Hafez, 2000). One fascinating thing about bird biology is that unlike mammals, the male reproductive system in birds is entirely inside the body. Yet bird sperm can survive and remain active at the bird's warm body temperature of around 41°C, something mammalian sperm cannot do (Brooks, 1990). Bird sperm are also shaped differently from mammalian sperm they are more elongated and have a longer midpiece, which is the section that powers their movement (Hafez, 1974). Before using semen for AI, its quality must be checked. Using poor-quality semen results in low fertility, increased embryo deaths, and wasted effort (Thurston, 1995). Key quality checks include:

- **Motility:** How many sperm are moving, and how well? Healthy semen has 60-80% motile sperm (Hafez and Hafez, 2000). Sperm motility is the single most important factor in determining fertility in chickens (Donoghue *et al.*, 1998).
- **Morphology:** Are the sperm normally shaped? Abnormal sperm those with bent tails, damaged heads, or missing parts cannot fertilize eggs. At least 85-90% of sperm should be normally formed (Peters *et al.*, 2008).
- **pH:** Semen that is slightly alkaline (pH 7.0–7.4) is ideal. Very acidic semen can damage sperm membranes (Latif *et al.*, 2005).

### Keeping Semen Alive: The role of extenders

Rooster semen begins losing quality within just one hour of collection if left untreated (Dumpala *et al.*, 2006). To preserve sperm quality long enough for AI, semen is mixed with special liquids called extenders or diluents. Extenders are carefully formulated salt solutions that mimic the natural composition of semen. They maintain the right pH level, provide energy sources for the sperm, protect the sperm membranes from temperature and chemical shocks, and allow one good semen sample to be spread across many more hens (Lake, 1995; Mian *et al.*, 1990). A well-known extender called Beltsville Poultry Semen Extender (BPSE) can keep semen viable for up to 24 hours when stored at around 4°C (Siudzinska and Lukaszewicz, 2008). Egg yolk is another natural ingredient sometimes added to semen extenders because it helps protect sperm from cold damage (Aboagla and Terada, 2004). Antioxidants can also be added to prevent a process called lipid peroxidation, which damages sperm membranes and shortens sperm lifespan (Jones and Mann, 1973).

### Insemination of Hen:

There are two main methods of depositing semen in poultry. By far the most common is vaginal insemination, also called intravaginal insemination, which was developed in the 1930s (Quinn and Burrows, 1936). The procedure requires two people and works as follows: one person holds the hen upside down while the other applies firm pressure to the left side of the hen's vent (cloaca). This pressure causes the vaginal orifice to evert (turn outward). A small insemination tube is then inserted 2-4 cm into the vagina, the semen is gently deposited, and the pressure is released. The natural relaxation of the cloaca then draws the semen deeper into the reproductive tract (Cole and Cupps, 1977; Aisha and Zain, 2010). Because hens often carry an egg in their oviduct in the morning, which would block the sperm's path, insemination is best done in the afternoon after the day's egg has been laid. Since semen loses viability within one hour of collection, insemination must begin immediately after semen is collected (Aisha and Zain, 2010). The second method, intra-peritoneal insemination, involves inserting a needle through the hen's abdominal wall to deposit semen near the ovary. This method is rarely used because it is unreliable and more stressful for the bird (Cole and Cupps, 1977). Once deposited in the vagina, sperm make their way up the oviduct, the tube where eggs are formed. Along the way, they enter special structures called Sperm Storage Tubules (SSTs), located at the junction between the vagina and the uterus (shell gland). These tubules act like a reservoir, storing sperm alive and releasing them gradually over days and even weeks (Froman and Feltmann, 2005).

This is one of the most remarkable facts in bird reproductive biology: chicken sperm can survive inside the hen for up to 32 days, and turkey sperm for as long as 70 days (Hafez and Hafez, 2000). This means that one insemination can result in fertile eggs for several weeks. Each time an egg yolk is released from the ovary, stored sperm are triggered to move toward it, and fertilization occurs at the top of the oviduct (Hafez and Hafez, 2000; Mauldin, 2000).

#### **Disease control using AI:**

When AI is done carelessly, it can spread disease rather than prevent it. Common contaminants include bacteria like *E. coli* and *Pseudomonas*, which can enter the semen during collection or through improperly prepared extenders. These organisms can kill sperm, cause systemic illness in hens, and lead to infertility (Van Eck and Goren, 1980). To address this, antibiotics such as penicillin and gentamicin are sometimes added to semen extenders. However, this must be done carefully, as some antibiotics can themselves reduce sperm quality (Donoghue *et al.*, 2004). The best approach is to prevent contamination in the first place through strict hygiene during collection, careful preparation of all equipment, and regular health monitoring of the breeder flock (Turin *et al.*, 1999).

#### **Conditions Affecting Semen Quality in Roosters:**

Not all roosters produce the same quality or quantity of semen. Several factors influence this, including breed and genetics some breeds naturally produce more semen than others (Lake, 1983). Age

and body condition matter too. Hormones play a central role: semen production is driven by a chain of hormonal signals beginning in the brain (the hypothalamus), passing through the pituitary gland, and ending in the testes where sperm are made and testosterone is produced (Senger, 2003; Hafez and Hafez, 2000).

Diet and management practices also matter, a well-nourished rooster living in a stress free environment will produce better semen than one that is overcrowded, malnourished, or poorly managed. Seasonal changes, particularly in day length, can affect hormone levels and therefore semen production in some breeds (Saeed and Al-Soudi, 1975). For AI to succeed, selecting only the best males with proven semen quality is essential.

### Conclusion:

Artificial insemination in poultry is a well-established and essential technology in modern production systems. It enables efficient use of superior males, reduces the number of cockerels needed, overcomes mating difficulties in heavy breeds, and limits disease transmission. Its success depends on proper semen collection, evaluation, handling, and timely insemination. Additionally, the natural ability of hens to store sperm for extended periods enhances fertility and makes AI highly practical for farm management. AI remains a key tool for improving productivity, genetics, and biosecurity in poultry farming, making its understanding essential for effective and sustainable production.

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