

Bibliometric Analysis of Artificial Insemination in Birds: A Scopus-Based Science Mapping Using VosViewer

Rief Ghulam Satriya Permana^{1*}, Yanuartono², Soedarmanto Indarjulianto², Erif Maha Nugraha Setyawan³, Anggitya Nareswari⁴, Shafa Adea Puspitadesy⁵

¹Doctoral Program in Veterinary Sciences, Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia

²Department of Internal Medicine, Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia

³Department of Reproduction, Obstetric and Gynecology, Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia

⁴Department of Biology Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia

⁵Magister Program of Veterinary Sciences, Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia

ABSTRACT

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Artificial insemination of birds is used in the poultry industry for genetic improvement and in conservation beyond natural habitats. Though it is commonly used in domestic poultry and becoming more popular in other bird species, the literature on the subject remains scattered across reproduction, semen preservation, genetics, microbiology, and animal health. This study seeks to determine the structure and thematic development of research on artificial insemination of birds through a bibliometric analysis of the Scopus database using VosViewer. After searching for literature on the Scopus database using the keywords “artificial insemination” AND bird, 406 documents were found. Bibliometric analysis was performed using keyword co-occurrence in combination with network, density, and overlay maps. The term artificial insemination, together with chicken, animal disease, genetics, microbiology, semen preservation, and polymerase chain reaction (PCR), was found to be the focus of the research. The network map defined four basic thematic areas: (i) reproductive technology and poultry production; (ii) semen quality and preservation; (iii) analysis of animal diseases and bacteriology; and (iv) molecular genetics. The overlay map indicated a change in the focus of research from the fundamentals of artificial insemination and the evaluation of semen to the investigation of pathogen-related research, genetic variability, and sex determination. This research concludes artificial insemination of birds is a production tool that has grown beyond the poultry industry to cover other areas such as food security and genetic conservation as well as animal welfare and biosecurity. Research should now be directed toward the development of species-specific preservation of semen, including the microbiology of semen and pathogen assessment, as well as assisted reproduction of wild and endangered bird species.

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Corresponding Author:
Rief Ghulam Satriya Permana

INTRODUCTION

The use of artificial insemination in avian species has proven to be a useful tool in poultry and pet breeding as well as in captive small animal breeding and avian conservation efforts. Controlled semen transfer from one male to one or more females facilitates planned genetic transfer and the management of breeders and hatchery breeding (control of fertility). In domestic fowl, the use of artificial insemination as a management tool for breeding, especially heavy breeds in which natural breeding is inefficient, is of great importance (Partyka & Nizański, 2022).

In non-native and endangered species of birds, artificial insemination progressively becomes a necessary part of ex situ conservation programs, especially in absence of successful natural mating due to behavioral incompatibility, low population size, physical barriers, or poor synchrony of reproductive behavior (Blanco et al., 2009). In the past, some studies reported on the use of artificial insemination and semen cryopreservation on small and closed populations of endangered birds to help mitigate some challenges of small populations. The authors found that the biggest challenges remain the quantity and quality of available semen as well as the stress caused to the birds by handling for insemination. (Bezerra et al., 2024).

Avian reproduction features important features that differ from mammalian reproduction. For instance, birds have internal testes, small volume semen in many species, and some birds possess specialized sperm storage tubules in their oviducts. There is great variation among birds in how different species are able to be studied in terms of semen collection and processing, cooling, and insemination (Lierz et al., 2013). There are multiple components that affect success of artificial insemination in birds, which include semen's quality, the number of sperm in a given volume, how quickly the sperm move, and whether the sperm are alive (Bakst & Dymond, 2013). In commercial poultry production, the ability to collect and transport semen is critical for the successful implementation of modern breeding and genetic programs (Arif et al., 2025).

There are two main methods used to preserve poultry semen: liquid storage and cryopreservation. Both techniques are technically difficult due to issues such as cooling, osmotic stress, cryoprotectant toxicity, oxidative stress, and membrane disruptions which almost completely diminish sperm motility, viability, and fertilizing ability (Partyka & Nizański, 2022; Maapola et al., 2025). The last few years have seen great improvements in the field of avian semen preservation, mainly in the improvement of extenders and cryoprotectants, addition of antioxidants, augmentation of freezing and thawing techniques, and improvement of fertility testing assays (Arif et al., 2025).

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The literature on artificial insemination of birds has greatly expanded beyond handling of semen and implications on semen fertility. This has reflected the understanding that the outcome of avian reproductive efforts is a result of many factors surrounding semen, the male, the female, the ability of the female to store viable sperm, the presence of pathogens, the genetic background of the birds, the welfare concerns of the birds, and the prevailing environmental conditions (Gee et al., 2004; Bezerra et al., 2024). Research on birds has benefitted greatly from the integration of molecular tools because they can now investigate genetic diversity, gene expression, and determination of sex, as well as assess the performance of avian reproduction (Lierz et al., 2013).

Furthermore, reactions to the application of artificial insemination in animals have highlighted issues of pathogens, biosecurity and antimicrobial resistance (Blanco et al., 2009). Although the number of studies related to this specific topic has increased, studies remain scattered across different fields, making it difficult for authors to identify major and minor topics or research gaps. Authors require a systematic map that prioritizes the major topics of the literature and the relationships among the various themes and gaps requiring interdisciplinary research (Donthu et al. 2021). Bibliometric analysis is an effective tool for mapping large research areas because it is designed to identify implicit structures and emerging trends in literature (Page et al. 2021). VosViewer is a citation mapping software that is capable of generating keyword co-occurrence, co-authorship, citation, bibliographic coupling, and co-citation networks (van Eck & Waltman 2010).

Recent years have seen an increase in the use of bibliometric analysis in reproductive studies, with a focus on research trends and gaps. This study uses a Scopus-based bibliometric dataset and VosViewer to map the research on avian artificial insemination. This study aims to find top keywords, cluster analysis, examine the shift in research focus over time and draw a research agenda for avian reproductive biotechnology, semen preservation, animal health, and One Health-oriented biosecurity. This study expects to provide researchers, practitioners and policymakers with a detailed map that outlines potential research areas and partnerships for artificial insemination of birds.

MATERIALS AND METHODS

This study combines a descriptive bibliometric approach with science mapping. The bibliometric part describes the structure of literature. Science mapping builds on the definition of recurrent terms in the publications. A transparent database search combined

with a reproducible bibliometric analysis guides the reporting. The PRISMA 2020 guidelines were used for documenting search identification, screening, and the inclusion of studies. Though my study does not follow the policy of systematic review on intervention effects (Page et al., 2021), I have tried to follow PRISMA as far as possible.

Records were extracted from the Scopus database. Relatively large multidisciplinary abstract and citation databases used for bibliometric studies in several fields of science, technology, medicine, and the social sciences are Scopus (Baas et al., 2020). Scopus as a single data resource for bibliometric studies have been employed to various disciplines and in Indonesia (Septriani et al., 2025). The literature search was performed on June 15, 2026. Keywords “artificial insemination” and bird were searched in the TITLE-ABS-KEY. The use of the asterisk wildcard is to include variants of the word bird, for example, bird, birds, or birdie. The time span of the publication was set to cover all years including 2026 with no first year set, and the document type limited to articles and reviews published in English.

An initial search of 406 documents was performed. No additional manual screening was needed because scopus includes all documents associated with the searched keywords. Since the point of this study was to capture the available research on this topic as fully as possible, all related search results from Scopus were used in the initial corpus. The bibliographic data that was downloaded contained the following: bibliographic records, abstracts, author keywords, index keywords, cited references, affiliation, funding information, and citation data. Bibliometric analysis was performed with VosViewer Software version 1.6.20 (van Eck & Waltman, 2010).

The program VosViewer allowed for the generation and visualization of keyword co-occurrence maps. Three types of visualizations were studied for this research; they included network, density, and overlay. In the network type, size of keywords represented frequency of occurrence. Co-occurring keywords were represented by connecting lines. Lastly, the clusters in the network map were shown in different colors, which were generated by the VosViewer algorithm. For the overlay visualization, each keyword was colored by the mean year of publication, indicating a shift in the theme over time. Lastly, in the density visualization, degrees of concentration of keywords were shown in yellow to red, with yellow being less concentrated and red being more concentrated.

I employed the following analysis settings: full counting to count each occurrence of a keyword in a document, minimum occurrence threshold of 5, association strength normalization (which is the default method in VosViewer). I used all keywords (author keywords and Scopus index keywords) as the unit of analysis. I merged duplications and synonyms using the thesaurus file (e.g. artificial insemination/insemination artificial). This prevented information from being distorted in the map.

Map interpretation was framed through the disciplines of veterinary reproductive science, poultry science, conservation biology, and One Health. Terms were classified into thematic clusters based on their position, relationship, and biological relevant. The focus was on the thematic concentration and the relationships between concepts. This study used only bibliographic metadata and published literature. It did not use live animals, human participants, clinical samples, or private data. Hence, ethical approval was not necessary for this study.

RESULTS AND DISCUSSION

Search Outcome and Dataset Scope

The Scopus database search using the keywords "artificial insemination" AND bird yielded 406 documents. According to the mapping results, this literature corpus spans many fields of science such as poultry production, avian reproductive biology, semen evaluation, semen preservation, animal disease, microbiology, virology, immunology, molecular genetics, sex determination, etc. This large range of disciplines indicates that artificial insemination in birds has become a multi-faceted topic beyond a mere technical procedure for breeding (Bakst & Dymond, 2013; Donthu et al., 2021). The range of fields involved also represents the numerous complexities which exists in artificial insemination of birds, where the reproductive aspects cannot be studied in isolation from animal health, genetics, and conservation biology. This further indicates that this field of study requires an integrated research approach that cuts across many fields of knowledge and brings together different areas of specialization in order to increase the understanding of the research under study.

Network Visualization

As shown in Figure 1, the term “artificial insemination” is the largest and most central node. Being adjacent to the term “insemination artificial” is a duplicate indexing issue needing correction by final analysis with a thesaurus file. Some key terms are: animal disease, chicken, nonhuman, animalia, genetics, microbiology, semen preservation, spermatozoon count, immunology, virology, polymerase chain reaction, and genetic variability (van Eck & Waltman, 2010). “Chicken” has the most centrality, which implies that domestic poultry is still the most important experimental and applied model in this literature.

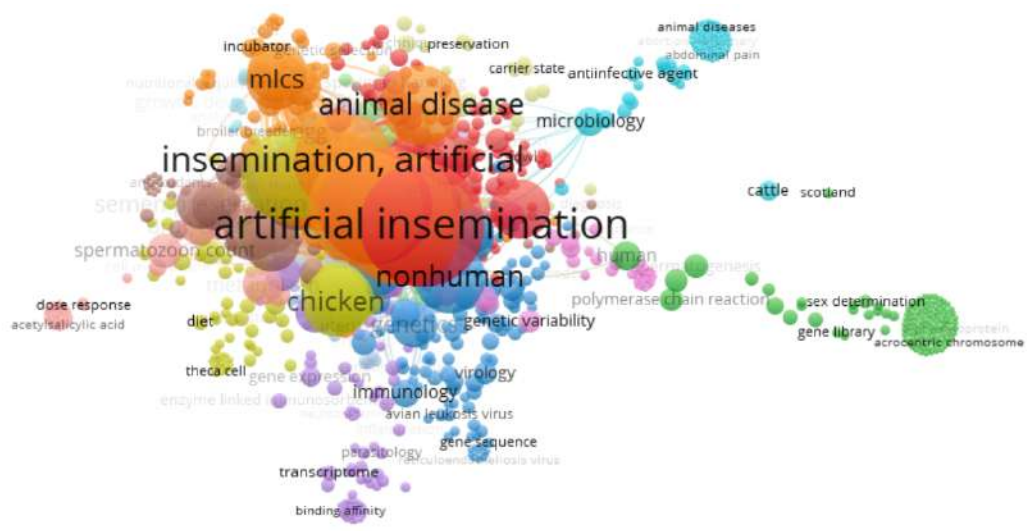
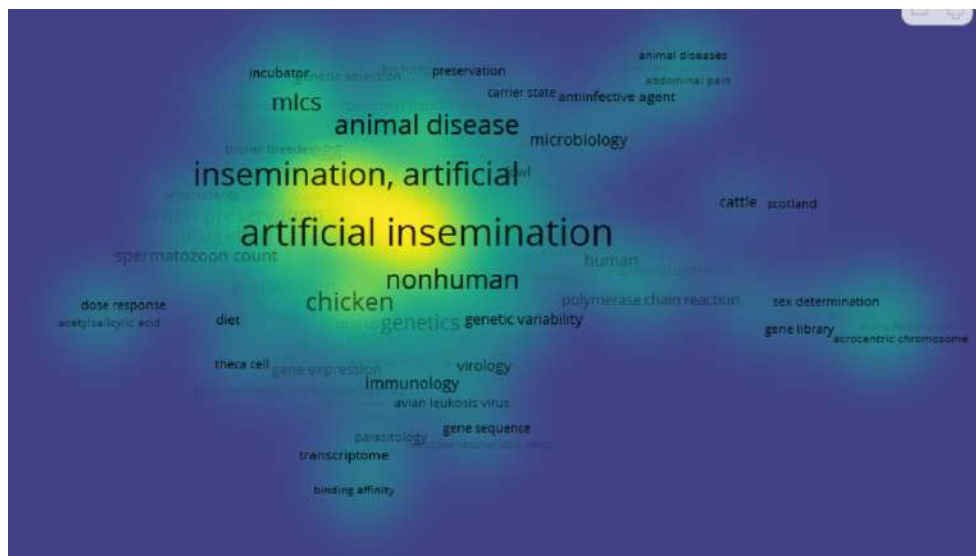


Figure 1. Network Visualization of Keyword Co-Occurrence on Artificial Insemination in Birds

This map illustrates four large thematic regions. The first region aims at poultry production and reproductive technologies. Terms like artificial insemination, semen, spermatozoon count, chicken, fertility, male, egg, broiler breeder and diet are located in this region. Proximity of terms indicates that artificial insemination research is connected to the commercial poultry production sector (Bakst & Dymond, 2013; Partyka & Nizański, 2022). The second region is related to animal health and diseases, and includes terms like animal disease, microbiology, virology, avian leukosis virus, anti-infective agent, carrier state, diagnosis, polymerase chain reaction, etc. Including this region tells us that when thinking about artificial insemination, researchers are interested in the success of the process and the risks of biosafety and the spread of diseases (Baas et al., 2020).

The third domain includes genetics and molecular biology with terms including genetics, genetic variability, gene expression, gene sequence, transcriptome, gene library, sex determination, and acrocentric chromosome. This indicates the growing role of molecular tools in genetic selection, pathogen diagnostics, and reproductive biomarker discovery (Lierz et al. 2013; Arif et al. 2025). The fourth domain includes terms such as preservation, specimen handling, incubation, and cold exposure that address the methodology of semen preservation in the context of semen preservation research that is a major technical challenge in artificial insemination (Bezerra et al. 2024; Gee et al. 2004).

The density map in Figure 2 shows that the terms artificial insemination, insemination artificial, chicken, animal disease, and nonhuman are the terms appearing twice as much as the others. This actually demonstrates that the literature is focused on artificial insemination as a form of reproduction, poultry as the primary avian class and diseases as an important connected theme (van Eck & Waltman, 2010). The rest of the terms appearing in the map (e.g. sex determination, gene library, acrocentric chromosome, etc.) appear in smaller low-density regions, suggesting different, more focused subfields or even more narrowed research. The low density of these terms also shows that these fields of research are largely undiscovered and thus lack development (Donthu et al., 2021; Page et al., 2021).



Permana et al, Bibliometric Analysis of Artificial Insemination in Birds: A Scopus-Based Science Mapping Using VosViewer Overlay Visualization

The overlay visualization in Figure 3 demonstrates that early research specifically focused on artificial insemination, chicken reproduction, semen traits, and basic preservation. Other terms, such as diagnosis, gene sequence, genetic variability, sex determination, animal diseases, and microbiology, are published in later years on average and indicate a shift towards molecular and disease-related topics (van Eck & Waltman, 2010). The artificial insemination research on birds illustrated a shift from a reproductive focus to a focus on integrating research with molecular and diagnostic sciences. This shift reflects a global trend within the field of reproductive biotechnology, where more and more molecular tools are integrated to add a greater degree of precision and impact to the field (Lierz et al., 2013; Arif et al., 2025).

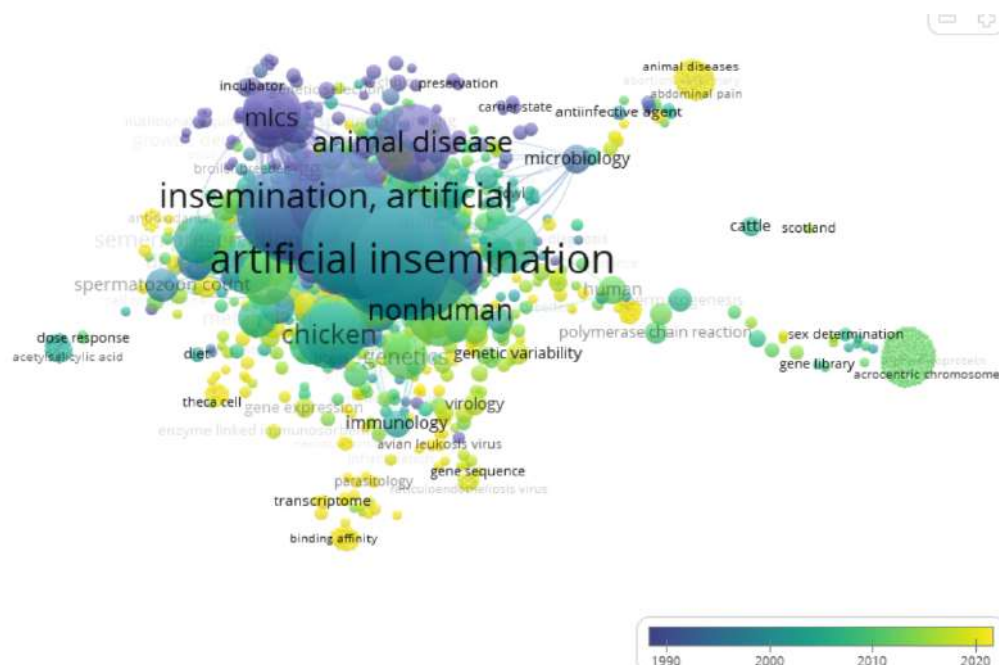


Figure 3. Overlay Visualization of Keyword Co-Occurrence on Artificial Insemination in Birds.

Thematic Structure of Research

The VosViewer map indicates four main research domains for avian artificial insemination research, as illustrated in Table 1.

Table 1. Thematic Structure of Artificial Insemination Research in Birds

Thematic Domain	Representative Terms	Interpretation	Future Research Priority
Reproductive Technology and Poultry Production	artificial insemination, chicken, semen preservation, spermatozoon count, egg, male, broiler breeder, fertility.	This is the notion that defines the area. The majority of research is on poultry breeding, semen handling, and the end results regarding fertility.	Develop species-specific insemination dose, semen extender, storage time and fertility prediction protocols.
Semen Quality and Preservation	semen preservation, spermatozoon count, cold, specimen handling, antioxidants, metabolism, cell membrane.	Semen quality still poses a major problem for the success of artificial insemination, even with storage or cryopreservation.	Oxidative stress markers, membrane integrity, texture of motility, kinetics, proteomics, and post-thaw fertility can be integrated.
Animal Health and Disease	Animal disease, Microbiology, Virology, Avian Leukosis Virus, Carrier State, Antiinfective Agent, Diagnosis.	Artificial insemination research combines issues of pathogen safety, disease transmission, and biosecurity of breeding systems.	Design One Health frameworks for semen hygiene, pathogen screening, prudent use of antimicrobials, and humane conduct.

Thematic Domain	Representative Terms	Interpretation	Future Research Priority
Molecular Genetics and Diagnostics	genetics, genetic variability, gene expression, gene sequence, transcriptome, PCR, sex determination, gene library, acrocentric chromosome.	The use of molecular technologies in genetic selection, pathogen detection, and discovery of reproductive biomarkers is migrating in this direction.	Use genomics, transcriptomics, proteomics, and microbiome to identify fertility and semen resilience biomarkers.
Conservation and Non-Domestic Birds	birds, nonhuman, preservation, genetic variability, gene library	The map suggests conservation relevance, but central density remains dominated by poultry.	Expand artificial insemination and semen banking protocols for wild, endangered, and zoo-managed birds.

Source: VosViewer Analysis Results, 2026

Main Discussion

The bibliometric map suggests that artificial insemination of birds is an established research area that is still developing. The dominant position of artificial insemination and chicken reflects the historical and practical importance of livestock. The presence of the following indicates that the scope of research has extended to the molecular level: semen preservation, genetics, microbiology, virology, polymerase chain reaction and sex determination. This focuses on the control of pathogens and the management of genetic resources (Arif et al., 2025). In veterinary science, this is important because the success of bird reproduction is not just the outcome of the insemination technique, but also the quality of the semen, the physiology of the male bird, the storage of female bird sperm, the safety of the pathogens, the genetic background, animal welfare, and the environment (Bezerra et al., 2024).

Central position of chicken indicates that chicken is the main model as well as application platform. Artificial insemination is widely used in the poultry industry for various reasons such as planned use of superior males, controlled matings, genetic dissemination, and improvement in breeding efficiency (Bakst & Dymond, 2013). In industry, artificial insemination can be used to improve fertility management in situations where natural mating is suboptimal, especially in the larger breeds or specialized breeder systems. In a research context, the ease with which chickens can be manipulated presents an ideal model to study the various aspects of semen collection, sperm concentration, sperm motility, extender composition, storage temperature, and the time interval between successive insemination and the hatchability. (Partyka & Nizański, 2022).

There is a relevant connection between artificial insemination and semen preservation at the biological level. Fresh semen can support artificial insemination. However, there is a need for reliable storage for long-distance transport, genetic exchange, cryobanking, and conservation. Preservation of avian semen is still difficult. Sperm cells can lose membrane integrity due to dilution, cooling, freezing, and thawing (Bezerra et al., 2024). Recently, main reviews focused on the two systems of liquid and cryopreservation storage, as well as ongoing studies on extenders, cryoprotectants, antioxidants, osmotic balance, the rate of freezing and thawing, and predicting fertility (Arif et al., 2025; Maapola et al., 2025). In this map, this research supports the literature as the preservation of semen and the count of spermatozoa are located close to the artificial insemination key terms in the central area.

The portion of avian artificial insemination research dedicated to health-related topics as disease, microbiology, virology, carrier state, anti-infective agent, and diagnosis demonstrates a health dimension. This dimension relates to One Health, as semen collection and insemination connect animal reproduction, on-farm biosecurity, One Health, antimicrobial stewardship, and conservation medicine (Baas et al., 2020). Poor hygiene in a poultry breeding facility can lead to an increased level of microbes in semen and equipment. In a conservation context, pathogen transmission can be a concern if semen is moved between both local and international facilities and screening is inadequate (Gee et al., 2004). As such, research based on artificial insemination should include semen hygiene, testing of pathogens, the disinfection of equipment, the training of staff, and the monitoring of welfare and data.

The use of terms such as genetics, genetic variability, gene expression, gene sequence, transcriptome, gene library, and polymerase chain reaction show a molecular aspect of the biotechnology field. The use of molecular tools to aid genetic selection, sex determination, pathogen identification, and the discovery of biomarkers is rapidly growing in reproductive biotechnology (Lierz et al., 2013). For research into avian semen, proteomic and molecular methodologies can discover proteins and pathways pertaining to sperm motility, stability of the membrane, resistance to oxidative stress, and the potential to fertilize. This is an important area of research because conventional semen parameters often are inadequate in accurately predicting fertility. It is necessary to have a more predictive approach which integrates semen concentration, motility, viability, membrane integrity, the oxidative state, safety from a microbiological perspective, and molecular markers (Arif et al., 2025; Maapola et al., 2025).

The benefits of artificial insemination for rare and non-domestic birds are especially significant when the natural reproduction of small or endangered populations is hampered by behavioral incompatibility, lack of synchrony, small population size, or physical

limitations. The VosViewer map shows that the literature is dominated by poultry and chickens. This dominance indicates a prominent research gap (Blanco et al., 2009). Although the protocol of semen collection, dilution, cooling, cryopreservation and insemination can be detailed for chickens, these protocols cannot be described in similar detail for wild birds. This is mainly due to differences in volume of semen, concentration of sperm, stress response, reproductive behaviors, and the anatomy of birds. Research on wild birds should develop protocols for each species and include the outcome of each procedure on the welfare of the birds, handling time, and the characteristics of the semen. Additionally, the assessed research should include the outcome on the fertility of the birds and the ability to hatch the eggs (Gee et al., 2004; Bezerra et al., 2024).

A further methodological issue with the provided map is the presence of artificial insemination and insemination artificial as separate central concepts. This indicates that the final VosViewer analysis would require a thesaurus file. Without this, the map has the potential to split the true frequency and centrality of a concept into two nodes (van Eck & Waltman, 2010). This would also be an issue for animal disease and animal diseases, polymerase chain reaction and PCR, and potentially bird and birds. Respected journals will require you to provide a thorough description of how you addressed the issues and an accompanying sensitivity analysis.

The VosViewer map presents a chapter-defining opportunity to apply a theory to avian artificial insemination (AI). The model purports that elements of reproductive technology, semen biology, health safety, and molecular and genetic technologies merge to create an ideal model of avian AI. The reproductive technology considers the collection, preparation, placement, and timing of the procedure. Semen biology focuses on the concentration and the quality, motility, viability, and oxidation state of the membrane as well as its fertilizing capacity. Health safety involves the prevention of the introduction of contaminating pathogens and the biosecurity and welfare of the AI subject. In molecular and genetic technology, the model includes genetic selection and changes the sex of birds and the discovery of fertility biomarkers and the value of the genetic material to conservation.

Bibliometrics is a powerful tool for discovering the structure and development of knowledge in all research areas, including animal reproduction (Okhovati et al., 2015). Bibliometrics shows the ongoing area of research, existing gaps in knowledge, and potential partners for collaborations, and aids in the formulation of research plans (Donthu et al., 2021).

CONCLUSION

This study examined the semantic network structure and key concepts of artificial insemination research in birds through a bibliometric analysis of 406 documents in the Scopus index. Using VosViewer, the network shows the core of this area comprises artificial insemination, chicken, animal disease, genetics, microbiology, semen preservation, and polymerase chain reaction. Of these, artificial insemination and chicken indicate that the focus discipline is research in domestic poultry, with the emphasis on the commercial poultry production sector. The network illustrates four main thematic areas: reproductive technology, semen preservation, animal disease, and molecular genetics.

These four categories suggest that artificial insemination research in birds has transitioned from a unidimensional, technical, reproductive-based science to a multidimensional, reproductive science. Overlay visualization demonstrates how research interest has evolved from fundamental studies of artificial insemination and semen evaluation to more advanced research of diagnostics, pathogens, genetic variability, and sex determination. This shows research interest has merged with the molecular and diagnostic sciences in accordance with advances in reproductive biotechnology globally. Density visualization demonstrates that the highest keyword intensity surrounds artificial insemination, chicken, and animal disease, while sex determination, transcriptome, and gene library are found at the periphery and have low keyword intensity, suggesting significant areas of research still to be undertaken.

The authors cited several key gaps and areas of future research. First, the authors noted the need for standardized protocols for the cryopreservation of semen, across different species. Second, the authors noted the need to incorporate the One Health framework into insemination protocols by integrating semen microbiology and pathogen testing. Third, the authors emphasized the utility of omics for the discovery of fertility biomarkers to increase the accuracy of predicted success of insemination. Fourth, the authors noted the priority for developing assisted reproduction technologies for wild and endangered birds, in an effort to assist conservation efforts on an international scale. It is important to note that artificial insemination for birds has evolved from a sole production technology to an allied multidisciplinary technology for food security and sustainable genetic resource management, animal welfare and biosecurity. This study has provided a significant reference to researchers, practitioners, and policy makers as a guide to identify research gaps and potential collaborations.

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REFERENCES

1. Arif, A., Zahoor, N., Tang, J., Tang, M., Dong, L., Khan, S. Z., & Dai, G. (2025). Cryopreservation strategies for poultry semen: A comprehensive review of techniques and applications. *Veterinary Sciences*, 12(2), 145. <https://doi.org/10.3390/vetsci12020145>
2. Baas, J., Schotten, M., Plume, A., Cote, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, 1(1), 377-386. https://doi.org/10.1162/qss_a_00019
3. Bakst, M. R., & Dymond, J. S. (2013). Artificial insemination in poultry. In S. Manafi (Ed.), *Artificial Insemination in Farm Animals*. *IntechOpen*. <https://doi.org/10.5772/54918>
4. Bezerra, L. G. P., de Oliveira, R. E. M., Comizzoli, P., & Silva, A. R. (2024). Collection, handling, and preservation of wild bird semen: Current status, challenges, and perspectives. *Biopreservation and Biobanking*, 22(3), 191-210. <https://doi.org/10.1089/bio.2023.0053>
5. Blanco, J. M., Wildt, D. E., Höfle, U., Voelker, W., & Donoghue, A. M. (2009). Implementing artificial insemination as an effective tool for ex situ conservation of endangered avian species. *Theriogenology*, 71(1), 200-213. <https://doi.org/10.1016/j.theriogenology.2008.09.019>
6. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285-296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
7. Gee, G. F., Bertschinger, H., Donoghue, A. M., Blanco, J., & Soley, J. (2004). Reproduction in nondomestic birds: Physiology, semen collection, artificial insemination, and cryopreservation. *Avian and Poultry Biology Reviews*, 15(2), 47-101. https://www.researchgate.net/publication/221962913_Reproduction_in_Nondomestic_Birds_Physiology_Semen_Collection_Artificial_Insemination_and_Cryopreservation
8. Lierz, M., Reinschmidt, M., Müller, H., Wink, M., & Neumann, D. (2013). A novel method for semen collection and artificial insemination in large parrots. *Scientific Reports*, 3, 2066. <https://doi.org/10.1038/srep02066>
9. Maapola, D., Ncube, L., Sibanda, R., & Chikwasha, T. (2025). Cryopreservation of avian semen: A comprehensive review of current techniques and future perspectives. *Animals*, 15(4), 529. <https://doi.org/10.3390/ani15040529>
10. Okhovati, M., Sharif, S., & Hosseini, S. M. (2015). Bibliometric analysis of scientific publications on animal reproduction. *Electronic Physician*, 7(5), 1597-1603. <https://doi.org/10.19082/1597>
11. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
12. Partyka, A., & Nizański, W. (2022). Advances in storage of poultry semen. *Animal Reproduction Science*, 246, 106921. <https://doi.org/10.1016/j.anireprosci.2021.106921>
13. Perez-Rivero, J. J. (2025). Advances in avian semen cryopreservation and artificial insemination. *Cryo Letters*, 46(1), 1-12. <https://doi.org/10.54680/fr25210110312>
14. Septriani, D., Andriyanto, A., & Rahayu, S. (2025). Bibliometric analysis of artificial insemination research in Indonesia: A Scopus-based study. *Rumphius Journal of Science and Technology*, 3(1), 15-28. <https://rumphius-journal.com/index.php/rjst/article/view/45>
15. van Eck, N. J., & Waltman, L. (2010). Software survey: VosViewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523-538. <https://doi.org/10.1007/s11192-009-0146-3>