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Exploring Trends in Caponization Research in Male Chickens: A Bibliometric Approach

Thobela Louis Tyasi

Department of Agricultural Economics and Animal Production, University of Limpopo, Private Bag X1106, Sovenga, Limpopo, South Africa
***Corresponding author:** louis.tyasi@ul.ac.za

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ABSTRACT

Caponization is a castration of male chickens that results in reducing androgen levels, which leads to abdominal fat accumulation in capons. However, there is a lack of research using a bibliometric approach to explore the research status and trends in caponization. The study was conducted to provide a bibliometric mapping of articles published on caponization. The data of 52 articles published from 2002 to 2024 was collected from Web of Science Core Collection (WoSCC) database. This study observed that the highest number of articles were published in 2009 (n=6). The results showed that Chen KL (article=13), China (article=68) and Poultry Science (article=17, local citation=411) were the most prolific author, country and journal, respectively. The current hotspots in this field of study include "carcass composition," "growth performance," and "meat quality" according to the high centrality and high density in a thematic map. In conclusion, this study provides a comprehensive overview of the status and trends which could enable better understanding of development in caponization research over years and help to identify the knowledge gaps for future research.

Key words: Chicken castration, Capons, Chicken testicles, Cock, Roaster

INTRODUCTION

Chickens were originally domesticated in Southeast Asia over 8,000 years ago (Zaheer 2015; Chambers et al. 2017; Abdulwahid and Zhao, 2022; Cho et al. 2022; Fan and Wu, 2022; Singchat et al. 2022; Shao et al. 2022; Ren et al. 2023; Diffine et al. 2023; Nawaz et al. 2024; Senbeta and Keyata 2024; Gjøen and Jensen, 2024; Volsche et al. 2024; Shirin et al. 2025; Zhu et al. 2025). These birds are among the most significant domesticated species globally, providing essential sources of protein through eggs and meat (Padhi 2016; Hinsemu et al. 2018; Henuk and Bakti 2018; Nawab et al. 2018; Nkukwana 2018; Govoni et al. 2021; Lawal et al. 2020; Mengesha et al. 2022; Shao et al. 2022; Siegel et al. 2022; Fernandes et al. 2023; Sukhija et al. 2023; Yajie et al. 2023; Shirin et al. 2025). The meat production of chickens requires a critical improvement due to the increase in human population that results in an increase in demand for chicken meat (Castro et al. 2023; Dzungwe et al. 2024; Gesek et al. 2024). According to Zawacka et al. (2017), meat production can be improved by castrating chickens. Castration of chickens is called caponization, which is a procedure of removing the testicles in farm male animals which is commonly practice in veterinary care and animal husbandry (Mahmud et al. 2014; Dutta et al. 2020; Ryad et al. 2022). It serves multiple purposes in animals including reducing aggressive behavior, preventing unwanted reproduction and improving some traits (Aikpitanyi et al. 2020; Hossen et al. 2021; Wang et al. 2023; Wojciechowska-Puchałka et al. 2024). Caponization is a hormonal intervention which permanently controls metabolic processes in chickens (Kwiecień et al. 2019; Cuciureanu et al. 2021; Ye et al. 2024). Due to reduced synthesis of sex steroids, caponization increases the fat deposition in the carcass (Symeon et al. 2012; Guo et al. 2015; Amorim et al. 2016; Cui et al. 2018; Paudel et al. 2018; Murawska et al. 2019; Ding et al. 2022). Rikimaru et al. (2011) conducted research on caponization of Hinai-jidori chickens and reported that this procedure is effective on slow-growing meat-type chickens at early stages of development by improving the daily weight gain. Zawacka et al. (2017) conducted the research in caponization of Green-legged Partridge breed known as Polish chicken breed and found that caponization significantly improve the carcass quality parameters and chicken behavior. Although there are scientific studies conducted in the caponization, there is a lack of research on using a bibliometric approach to

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investigate the caponization. According to Han et al. (2020), Rejeb et al. (2020), Yaqoub et al. (2023) and Passas (2024), bibliometric analysis is a tool that enables researchers to examine scientific publications to gain insights into trends. It is essential to explore the bibliometric analysis in caponization to gain insights into the trends and status of the research in the field. The objective of the study was to use bibliometric analysis to gain insight into the status of and trends in research on caponization. The study will contribute to developing a more comprehensive framework for understanding the most prolific authors, nations, affiliations, articles, keywords and research directions in the field of caponizations.

MATERIALS AND METHODS

Data sources

The Web of Science Core Collection (WoSCC) was used to source data of related articles for bibliometric analysis. Uyanga et al. (2023) indicated that WoSCC is the reliable database utilized for bibliometric studies in various fields.

Search strategies

A comprehensive search on caponization was conducted on 14 February 2025. The following keywords were used: (Caponization OR "Male chicken castration" OR "Roaster castration" OR "Cock castration" OR "Chicken castration" OR "Cockerels castration"). S1 file (supporting document) is attached as the final dataset.

Inclusion and exclusion criteria

A total of 53 articles were screened for document type and one article was removed. Approximately 52 articles were screened for language and all were written in English and assessed for eligibility. No articles were excluded; therefore, all 52 articles were included in the study as shown in Fig. 1.

Data extraction

The "Export Records to File" and the "Full Records and Cited References" options were used for extracting the data from WoSCC database. The BibTeX format was used for downloading the full records of the 52 articles.

Bibliometric analysis

R Studio (version 4.3.0, 2022) was used for data analysis using the bibliometrix package in the R programming language (Aria and Cuccurullo 2017).

RESULTS

Descriptive statistics

Table 1 shows the summary of the data collected from the Web of Science Core Collection for bibliometric analysis. The findings showed that fifty-two (n=52) documents, which were published from 2002 to 2024, were extracted. The results also indicated that the annual growth rate of publications was 3.2% with the international co-authorship of 3.85% and average citations per document of 18.96.

Publications and citations per year

The distribution of publications and citations per year are presented in Fig. 2. The findings showed that the highest number of publications were published in 2009 (n=6) followed by 2016 and 2017 with five (n=5) publications each. The average total citations per year indicated that the highest number (3) was obtained in 2017 followed by 2005 with 2.75 and 2008 with 2.24.

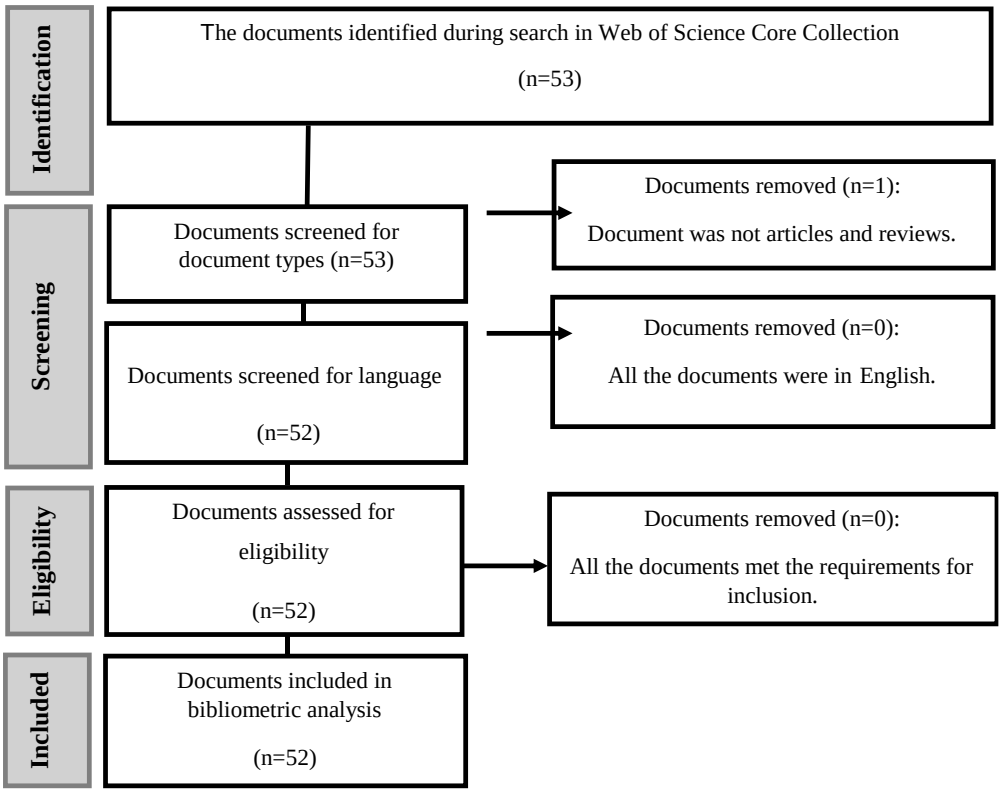

Fig. 1: Flow chart of identification and selection of studies used.

Table 1: Main information

Description	Results
Main Information About Data	
Timespan	2002:2024
Sources	17
Documents	52
Annual Growth Rate %	3.2
Document Average Age	11
Average citations per document	18.96
References	1021
Document Contents	
Keywords Plus (ID)	190
Author's Keywords (DE)	116
AUTHORS	
Authors	158
Authors of single-authored document	0
AUTHORS COLLABORATION	
Single-authored document	0
Co-Authors per document	5.44
International co-authorships %	3.846
DOCUMENT TYPES	
Article	52

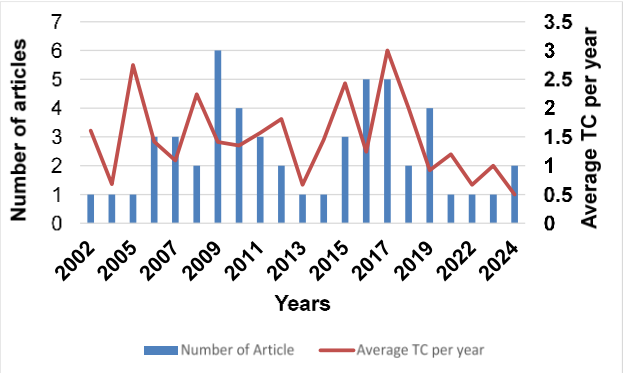

Fig. 2: Publications and average total citation per year.

Three-field plot

Fig. 3 shows a three-field plot based on the Sankey chart, which defines the relationship between three components (journals, authors, and keywords). The graph consists of a gray plot that connects the components and rectangles. The size of the rectangles in each component reflects the number of publications in each component. The findings showed that the top five authors (Chen KL, Kwiecien M, Muszynski K, Tomaszewska E and Jezewska-Witkowska G) published using caponization, capon, male chicken, bone characteristic and meat quality as the top keywords linked with Journal of Agricultural Association of China and Production, Journal of the Chinese Society of Animal Science, Poultry Science, Asian-Australian Jornal of Animal Sciences, Animal, International Journal of Poultry Science, Animal Research, Journal of Food Science and Technology Myso, and British Poultry Science.

Most relevant sources

The top ten most relevant sources from 2002 to 2024 are presented in Fig. 4. The sources were ranked according to the number of articles published. The findings showed that most articles were published in Poultry Science (n=17) followed by Asian Australian Journal of Animal Sciences with eight articles (n=8) and Annal of Animal Science with six articles (n=6) in each source.

Most local cited sources

Fig. 5 shows the most locally cited sources, which were ranked according to the number of citations. The results showed that Poultry Science had the highest number of citations (n=411) for the caponization field. The Asian Australian Journal of Animal Sciences was the second-highest cited journal with 116 citations.

Most relevant authors

Fig. 6 shows the most influential authors in the caponization field which were ranked according to the number of articles per author. The results showed that the top ten prolific authors were Chinese scholars (Zhang Y, Wang H, Lu L, Sun Y, Wang J, Chen, Chen J, Han H, Li Y and Liu H). The most prolific author was Chen KL with thirteen articles (n=13), followed by Chiou PWS with eight articles (n=8) and Muszynski S and Tomaszewska E with six articles (n=6) each.

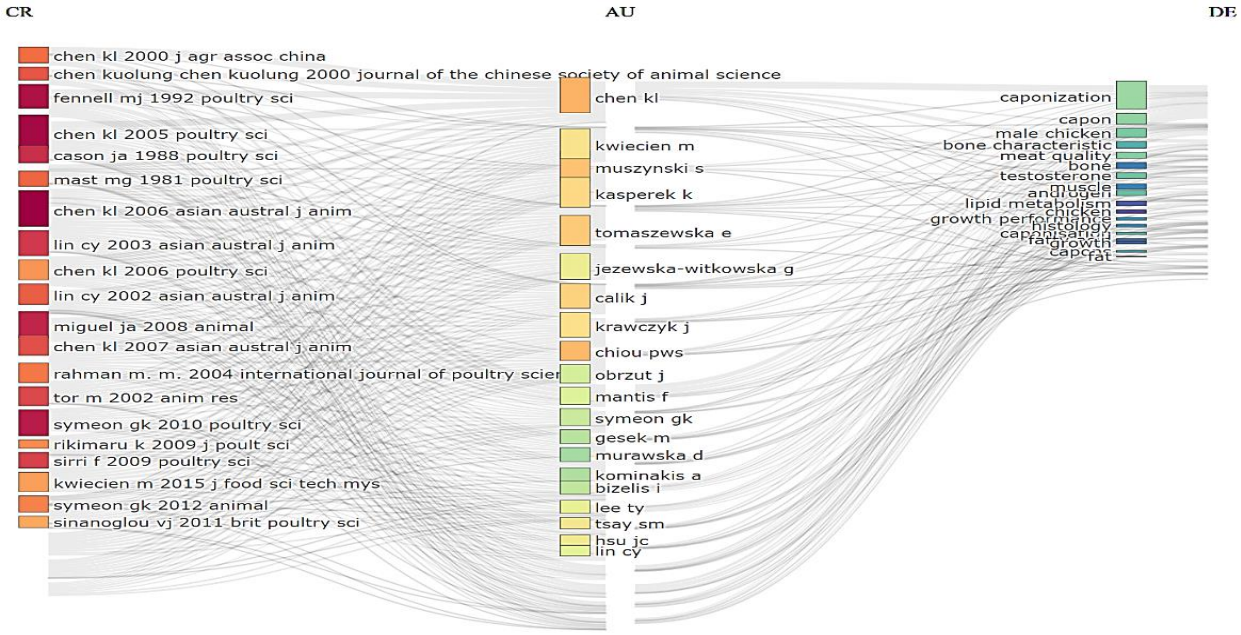

Fig. 3: A Sankey graph showing the relationship among journals (left), authors (middle) and keywords (right).

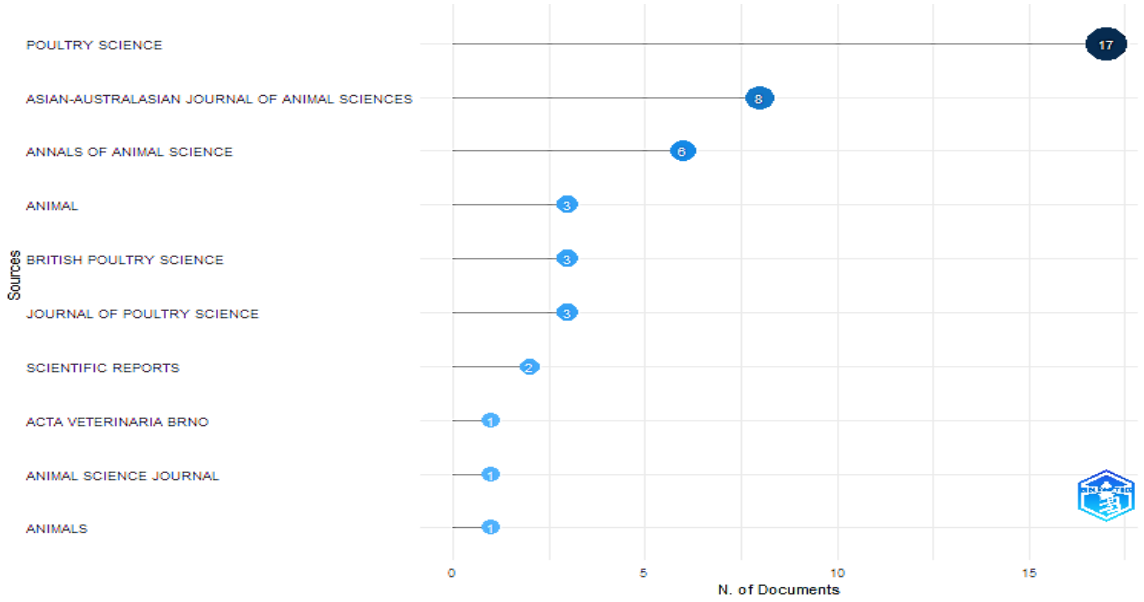

Fig. 4: Most influential sources.

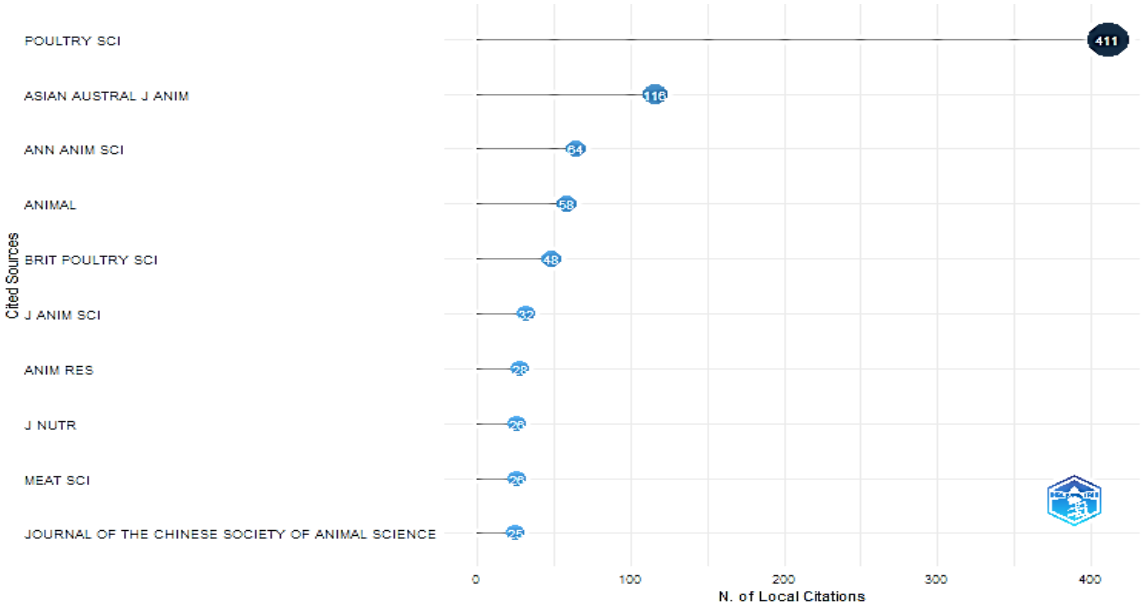

Fig. 5: Most local cited sources.

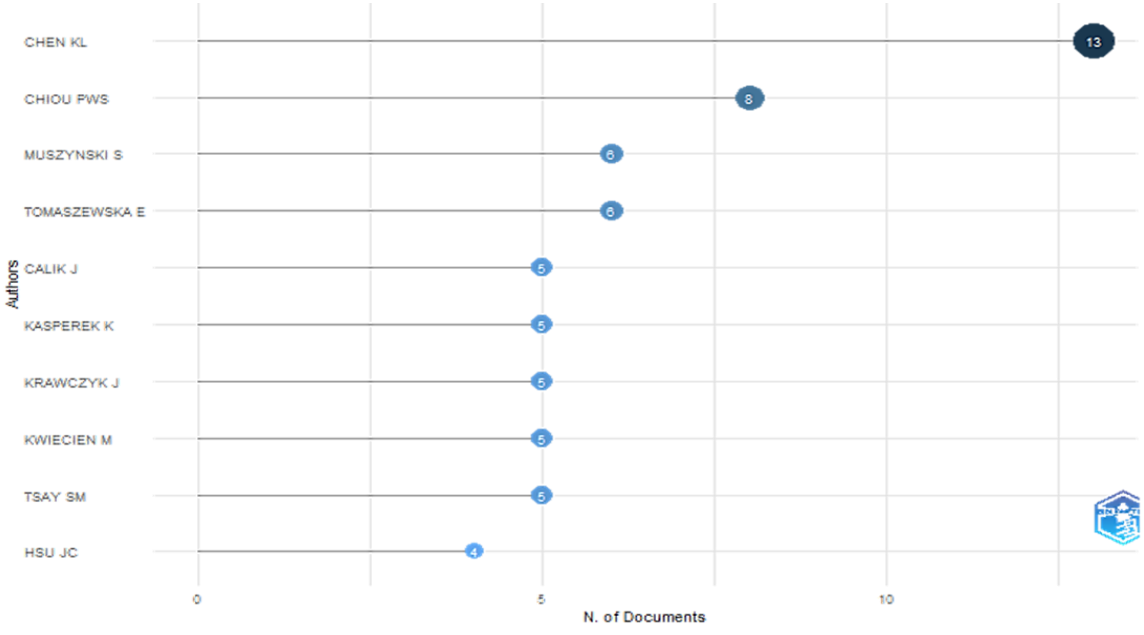

Fig. 6: Most influential authors; TC PER YEAR**:** Total citation per year.

Most cited authors

The top ten most cited authors which were ranked according to the number of citations in their articles are presented in Fig. 7. The results indicated that Asenjo B, Calvo VL, Ciria J and Miguel JA had the highest number of citations (n=23) followed by Bizelis I, Kominakis A, Mantis F, Rogdakis E and Symeon GK with sixteen citations (n=16) for each author.

Countries' scientific contribution

The production of each country was ranked according to the number of articles published. The results indicated that China had the highest number of articles (n=68) in the caponization field (Table 2). The Poland had the second highest number of articles (n=66) followed by Portugal (n=17) and Greece (n=14).

Table 2: Top 10 countries' with scientific contribution

Countries	Frequency
China	68
Poland	66
Portugal	17
Greece	14
Japan	9
Spain	6
Croatia	4
Italy	2
Ukraine	1
USA	1

Most globally cited documents

Table 3 shows the top ten most globally cited articles in the caponization field, ranked according to the total number of citations and total citations per year. The findings showed that the article of Miguel JA (DOI:10.1017/S1751731107001127) published in 2008 in Animal had the highest global citations (n=74) with total citations per year of 4.35. The article of Sirri F (DOI:10.3382/ps.2008-00405) published in 2009 in the Poultry Science had the second highest number of global citations (n=57) with total citations per year of 3.56.

Most cited references

Table 4 shows the top ten most cited references in the caponization field, ranked according to the total number of citations with Chen KL having the highest citation (n=34) for the year 2005 in Poultry Science followed by Symeon GK having the second highest citations (n=25) for the year 2010 in Poultry Science.

Word cloud

Fig. 8 shows the word cloud analysis for the most popular terms in caponization related articles. The words in bigger size are most frequently used in caponization articles and the word in smaller size is less frequently used. The findings show that the top ten most frequently used words were testosterone (frequency=17), carcass composition (frequency=16), growth performance (frequency =16), growth (frequency =13), meat quality (frequency=11), quality (frequency=10), caponization (frequency=9), testosterone implantation (Frequency=9), performance (frequency=8), capons (frequency=7).

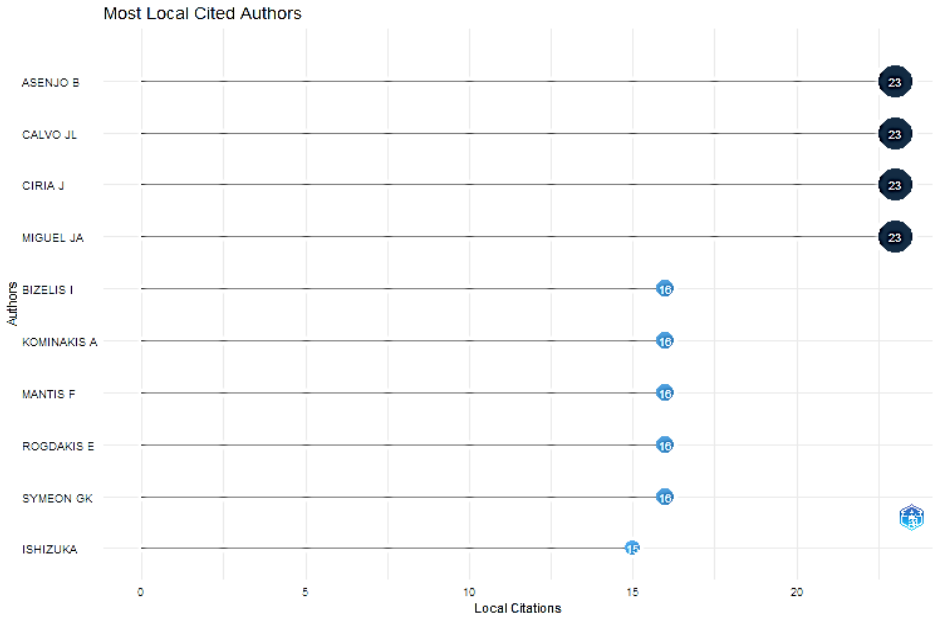

Fig. 7: Most locally cited authors.

Table 3: Top ten most globally cited documents

ARTICLES	DOI	TC	TC PER YEAR
Miguel JA, 2008, Animal	10.1017/S1751731107001127	74	4.35
Sirri F, 2009, Poultry Science	10.3382/ps.2008-00405	57	3.56
Chen Kl, 2005, Poultry Science	10.1093/ps/84.4.547	55	2.75
Muszynski S, 2017, Poultry Science	10.3382/ps/pew301	53	6.62
Symeon GK, 2010, Poultry Science	10.3382/ps.2009-00411	49	3.27
Chen Kl, 2006, Asian-Australasian Journal of Animal Sciences	10.5713/ajas.2006.438	42	2.21
Lin CY, 2002, Asian-Australasian Journal of Animal Sciences	10.5713/ajas.2002.401	37	1.61
Sinanoglou VJ, 2011, British Poultry Science	10.1080/00071668.2011.581269	34	2.43
Symeon GK, 2012, Animal	10.1017/S1751731112001024	34	2.62
Calik J, 2015, Annals of Animal Science	10.1515/aoas-2015-0002	30	3

Table 4: Top ten most cited references

CITED REFERENCES	CITATIONS
Chen KL, 2005, Poultry Science, V84, P547, DOI 10.1093/PS/84.4.547	34
Symeon GK, 2010, Poultry Science, V89, P1481, DOI 10.3382/PS.2009-00411	25
Chen Kl, 2006, Asian-Australasian Journal of Animal Science, V19, P438, Doi 10.5713/Ajas.2006.438	24
Miguel JA, 2008, Animal, V2, P305, DOI 10.1017/S1751731107001127	23
Fennell MJ, 1992, Poultry Science, V71, P357, DOI 10.3382/PS.0710357	21
Sirri F, 2009, Poultry Science, V88, P1466, DOI 10.3382/PS.2008-00405	21
Tor M, 2002, Animal Research, V51, P421, DOI 10.1051/ANIMRES:2002035	21
Cason JA, 1988, Poultry Science, V67, P979, DOI 10.3382/PS.0670979	20
Chen Kuolung, 2000, Journal of the Chinese Society of Animal Science, V29, P77	19
Lin CY, 2002, Asian-Australasian Journal of Animal Science, V15, P401, DOI 10.5713/AJAS.2002.401	19

Fig. 8: Word cloud.

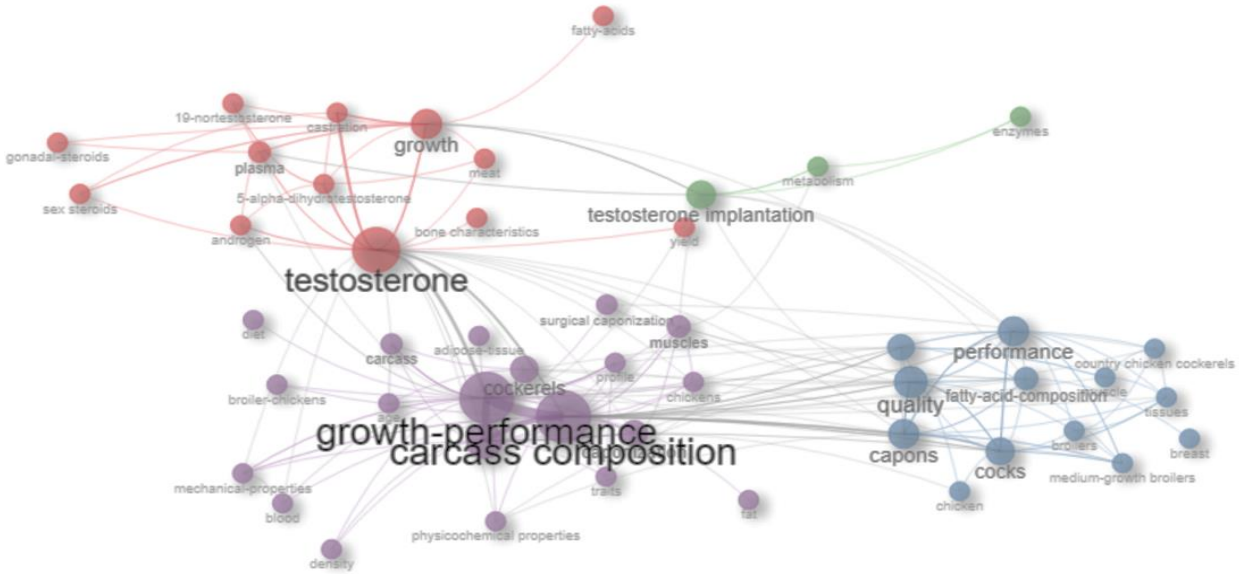

Fig. 9: Co-occurrence network.

Co-occurrence network

Fig. 9 shows the network of keywords interrelated by lines that represent the occurrence of the words in caponization articles published from 2002 to 2024. Each of the nodes represent the keywords and the size of the node is related to the frequency of appearance. The line between nodes represents that there is co-occurrence between nodes and the size of the line indicates the strength of the relationship. The results showed that 4 clusters with different colors were observed. Cluster 1 consists of 13 keywords, "testosterone", "growth", "caponization", "plasma", "5-alpha-dihydrotestosterone", "androgen", "bone characteristics", "sex steroids yield", "19-nortestosterone"," gonadal-steroids", "meat" and "fatty-acids". Cluster 2 consists of 13 keywords "quality", "performance", "capons"," cocks", "caponization", "fatty-acid-composition", "broilers", "country chicken cockerels", "muscle", "tissues", "chicken", "medium-growth broilers" and "breast". Cluster 3 has three keywords "testosterone implantation," "metabolism" and "enzymes". Cluster 4 has twenty keywords "carcass composition", "growth-performance", "meat quality", "caponization",

"cockerels", "carcass", "muscles", "surgical caponization", "age", "chickens", "profile", "adipose-tissue", "broiler-chickens", "mechanical-properties", "physicochemical properties", "traits", "blood", "density", "diet" and "fat".

Co-citation network

Fig. 10 represents the co-citation network of articles in caponization from 2002 to 2024. Each of the nodes represents the articles and the size of the node is related to the frequency of citation. The line between nodes indicates co-citation between articles and the size of the line indicates the strength of the association between articles. The co-citation network reveals two distinct research clusters with different colors. Cluster 1 with red color, centered around "Chen KL 2005" and "Fennell MJ 1992", represents early influential works with strong internal connections, indicating a closely related research focus. Cluster 2 with blue color, dominated by "Symeon GK 2010", "Symeon GK 2012", and "Lin CY 2002".

Author collaboration network

Fig. 11 represents the author collaboration network of articles in caponization from 2002 to 2024. Each of the nodes represents the articles and the size of the node is related to the frequency of citation. The line between nodes indicates author collaboration network between authors and the different colors represent different clusters. The results showed 10 clusters and distinct colors were observed. Cluster 1 had twelve authors "Muszynski S", "Tomaszewska E", "Calik J", "Kasperek K", "Krawczyk J", "Kwiecien M", "Jezewska-Witkowska G", "Obrzut J", "Wojtysiak D", "Dobrowolski P", "Grela ER" and "Poltowicz K". Cluster 2 had two authors "Hsu JC" and "Lin CY." Cluster 3 had ten authors "Chen Kl," "Chiou PWS," "Tsay SM"," Lee TY", "Chen TT", "Chen TW"," Chi WT", "Huang CC", "Lin KI" and "Lo DY". Cluster 4 had four authors "Gesek M," "Murawska D," "Michalska K" and "Otrocka-Domagala I". Cluster 5 had three authors "Adamski M," "Banaszak M" and "Kuzniacka J." Cluster 6 had three authors "Cui H," "Cui X" and "Li Q". Cluster 7 had three authors "Antunes IC," "Bessa RIB" and "Martins Da Costa P". Cluster 8 had five authors "Mantis F," "Symeon GK"," Bizelis I", "Kominakis A" and "Rogdakis E". Cluster 9 had four authors "Chen X," "Geng Z", "Guo X" and "Jiang R". Cluster 10 had four authors "Rikimaru K," "Ishizuka"," Johji J" and "Komastu M.

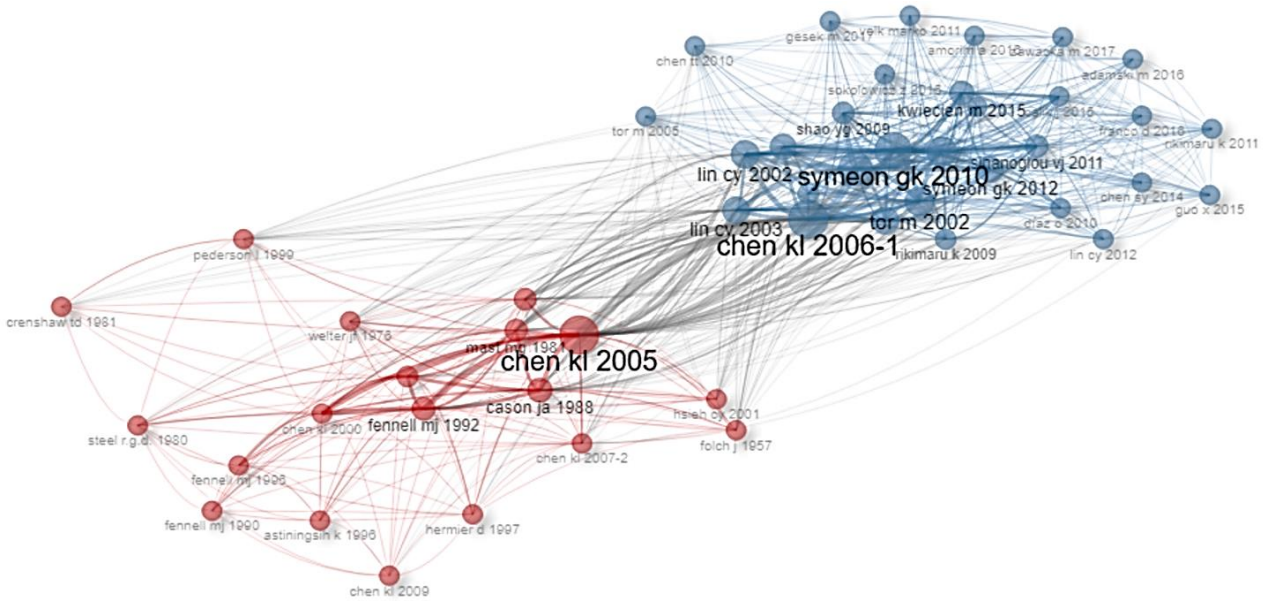

Fig. 10: Co-citation network.

Fig. 11: Author collaboration network.

Trends topics

Fig. 12 displays the trend topics in the field of caponization from 2002 to 2024. The most frequent topics were analysed for words that were used a minimum frequency of 5 times and maximum of 15 times on articles published from 2007 to 2019. The results showed that the trend topics were" carcass composition," "meat quality," "muscles," "growth performance," "capons," "quality," "caponization," "cocks," "performance," "testosterone implantation," "cockerels," "carcass," "surgical caponization," "testosterone,' "growth," "plasma" and "caponization."

Thematic Map

The thematic map analysis reveals that "carcass composition," "growth performance," and "meat quality" are motor themes, indicating they are well-developed and central to the research field as shown in Fig. 13. "Testosterone," "growth," and "caponization" appear as developing themes, showing growing interest in hormonal influences on poultry production. In contrast, "sex" and "density" are found in the emerging or declining themes quadrant, suggesting they are either gaining traction or losing relevance in recent studies.

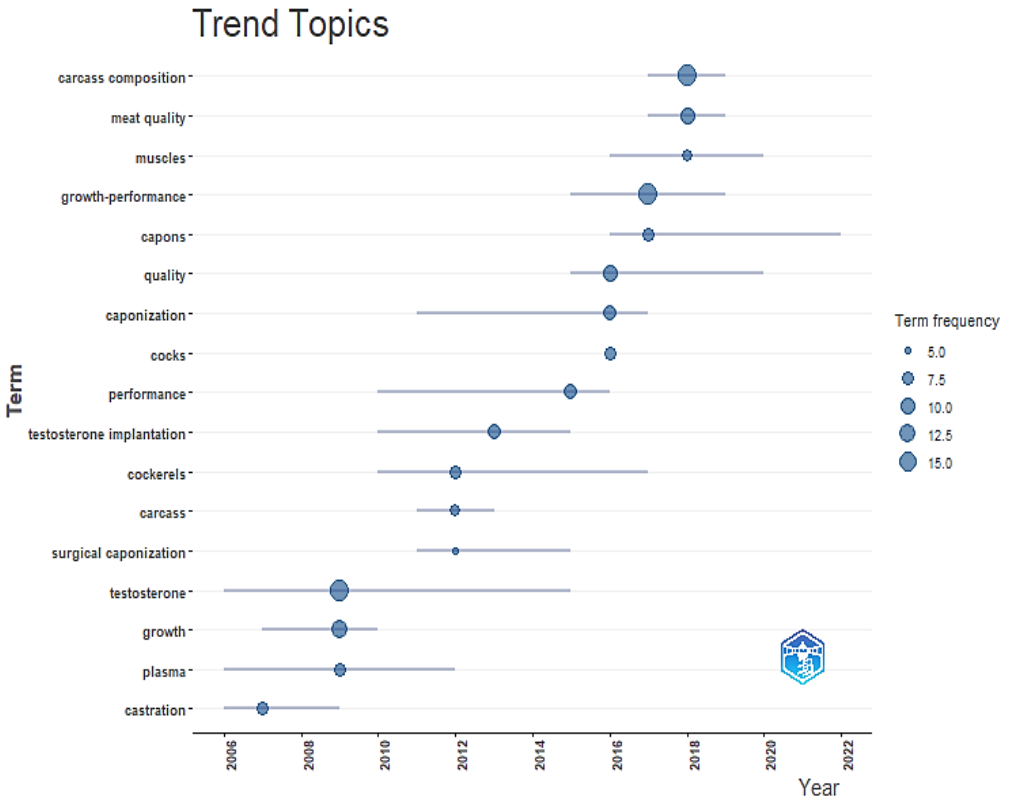

Fig. 12: Trend topics.

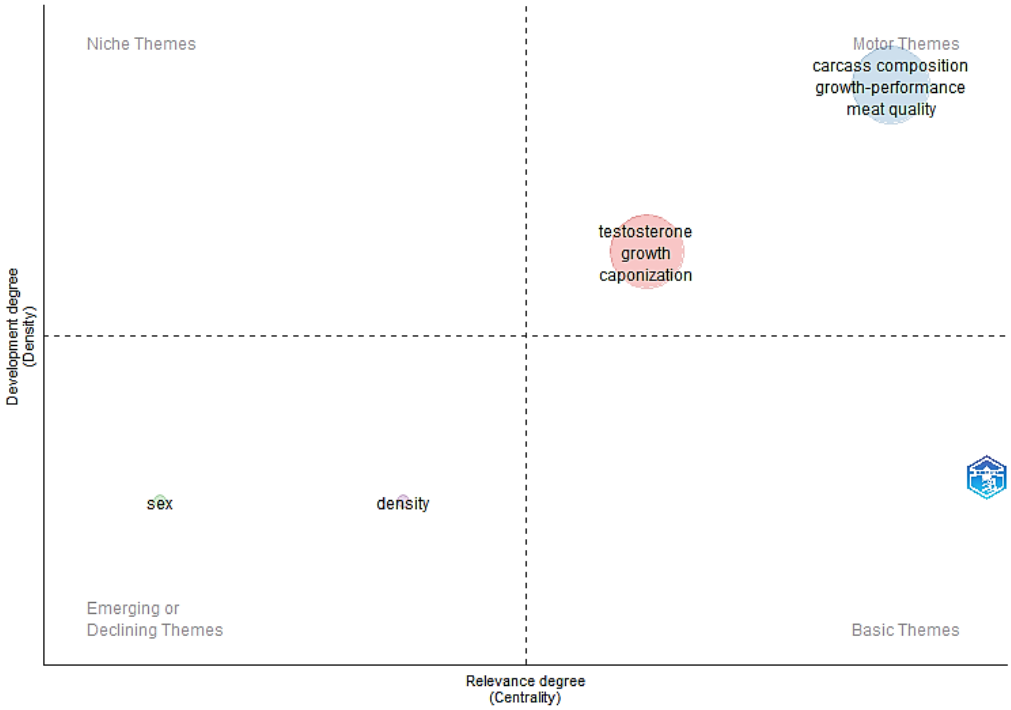

Fig. 13: Thematic Map.

DISCUSSION

Caponization is the practice of castrating male chickens to improve meat quality and alter their growth characteristics (Symeon et al. 2012). Kumar et al. (2023) explained that an analytical method that often uses systematic literature reviews for quantifying scholarly works is called bibliometric analysis. The study aimed at examining the status and trends of castration in poultry from studies published between 2002 and 2024 extracted from the Web of Science Core Collection database. A total of fifty-two (n=52) documents were retrieved, there was a fluctuation in the number of articles published with 2009 (n=6) having the highest number of articles, with average citation per document of 11 and annual growth rate of 3.2%. Although there is bibliometric analysis conducted in animal science, this is the first on caponization in poultry. Hence, there is limited bibliometric analysis resulting on caponization to compare the results of the current study. A bibliometric analysis was conducted by Susilo et al. (2024) on cage-free housing system in laying hens from 1960 to 2023 literature and found 900 publications with a mean of 19.4 citations per article and an average annual growth rate of 7.14%. Uyanga et al. (2023) conducted a bibliometric analysis on heat stress in poultry from the literature between 2000 and 2021 and found a total of 468 articles with an average citation of 24.11 per article and an annual growth rate of 4.56%. These results suggest that there is a gradual increase in the field of caponization research. The findings of this study revealed the leading research countries as China (n=68), Poland (n=66) and Portugal (n=17). However, Kandeel et al. (2023) found that USA, China and United Kingdom as the top three leading countries on the research of anticoccidial drugs evolution and its consequences in the academic and public worlds. Furthermore, Uyanga et al. (2023) found the leading countries on heat stress research as China (n=137), Turkey (n=56) and Brazil (n=49). However, Omar and Abdullahi (2024) found that USA (n=81) dominated with publications, followed by United Kingdom (n=56) and China (n=50). In addition, Omar and Abdullahi (2024), highlighted that the USA's leading position in poultry farming publications is unsurprising, as their publications are gaining the highest number of citations, indicating their increasing extensive recognition worldwide but so is China. The findings of the current study revealed that the Journal of Poultry Science had the highest number of articles and the highest citations for the caponization field. Journal of Poultry Science was also found by Susilo et al. (2024) as having the highest number of publications on cage-free housing systems in laying hens. These results suggest that Poultry Science Journal is the leading journal in fields related to poultry research. The current study revealed the most popular and emerging topics in caponization research as "carcass composition," "growth performance," and "meat quality," "Testosterone," "growth," and "caponization". Indicating they are well developed and central to the research field. In addition, keywords such as "carcass composition," growth performance," "growth," "meat quality, "quality" "caponization," "testosterone," "implantation," "performance" and "capons" were identified for future studies. The limitation of the study is that only Web of Science database was used for bibliometric analysis. As such, it is recommended that future studies include the usage of other databases such as Scopus, PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Google Scholar, Dimensions, CORE, BASE, Science.gov, Crossref API, Microsoft Academic Search, and JSTOR Data for Research.

Conclusion

In conclusion, there have been a total of 52 articles published from 2002 to 2024, collected from Web of Science Core Collection to provide a bibliometric mapping of articles published on caponization. Furthermore, this bibliometric analysis study provided a detailed and comprehensive analysis of caponization trends over two decades. It is expected to serve as a useful reference for potential future research that will help both researchers and farmers understand that caponization can improve meat production as it permanently controls metabolic processes in chickens allowing fat deposition in the carcass and daily weight gain.

DECLARATIONS

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Acknowledgement: None

Conflicts of Interest: None

Data Availability: All the data generated during the study is available upon request.

Ethics Statement: The author considered ethical issues like as plagiarism, data fabrication and writing with AI**.**

Generative AI Statement: The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

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REFERENCES

Abdulwahid AM and Zhao JB, 2022. China as a center of origin and domestication of chicken: A review. Agricultural Reviews 43(2): 170-177. http://dx.doi.org/10.18805/ag.R-206

Aikpitanyi K, Imasuen JA, Aikhu L and Keborkwu C, 2020. Evaluation of growth and carcass characteristics of ISA brown cockerels as influenced by age at surgical caponization. International Journal of Veterinary Sciences and Animal Husbandry 5(4): 169-174. https://doi.org/10.22271/veterinary.2020.v5.i4c.292

Amorim A, Rodrigues S, Pereira E, Valentim R and Teixeira A, 2016. Effect of caponisation on physicochemical and sensory characteristics of chickens. Animal 10(6): 978-986. https://doi.org/10.1017/S1751731115002876

Aria M and Cuccurullo C, 2017. A brief introduction to bibliometrix. Journal of Informetrics 11(4): 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Castro FLS, Chai L, Arango J, Owens CM, Smith PA, Reichelt S, DuBois C and Menconi A, 2023. Poultry industry paradigms: connecting the dots. Journal of Applied Poultry Research 32(1): 100310. https://doi.org/10.1016/j.japr.2022.100310

Chambers JR, Zaheer K, Akhtar H and Abdel-Aal ESM, 2017. Chicken eggs. In Egg innovations and strategies for improvements (pp. 1-9). Academic Press. https://doi.org/10.1016/B978-0-12-800879-9.00001-9

Cho Y, Kim JY and Kim N, 2022. Comparative genomics and selection analysis of Yeonsan Ogye black chicken with whole-genome sequencing. Genomics 114(2): 110298. https://doi.org/10.1016/j.ygeno.2022.110298

Cuciureanu CM, Usturoi MG, Radu-Rusu RM, Burtan LC and Fântânaru M, 2021. Studies on the productive performance of Hubbard roosters in the post-caponisation period. Scientific Papers-Animal Science Series: Lucrări Ştiinţifice - Seria Zootehnie 75: 183-186.

Cui X, Cui H, Liu L, Zhao G, Liu R, Li, Q, Zheng M and Wen J, 2018. Decreased testosterone levels after caponization leads to abdominal fat deposition in chickens. BMC Genomics 19(1): 1-10. https://doi.org/10.1186/s12864-018-4737-3

Diffine EA, Tiunova AA and Anokhin KV, 2023. Development of a model to study visual categorization learning in chickens (*Gallus gallus domesticus*). Genes & Cells 18(4): 702-705. http://dx.doi.org/10.17816/gc623417

Ding X, Giannenas I, Skoufos I, Wang J and Zhu W, 2022. The effects of plant extracts on lipid metabolism of chickens—A review. Animal Bioscience 36(5): 679. https://doi.org/10.5713/ab.22.0272

Dutta B, Deka RJ, Gogoi AK, Saikia BN, Mahanta JD, Laskar SK and Dutta C, 2020. Performance of caponized local chicken under different production systems for small scale production in resource poor settings. International Journal of Current Microbiology and Applied Sciences 9(10): 424-429. https://doi.org/10.20546/ijcmas.2020.910.052

Dzungwe JT, Tozo K, Chrysostome CA, Tankouano RA, Oke OE and Tona K, 2024. Effect of crossbreeding on egg quality, incubation, and hatching activities of the pure and reciprocal cross between the Sasso and Wassache chickens. Poultry Science 103(4): 103406. https://doi.org/10.1016/j.psj.2023.103406

Fan H and Wu J, 2022. Conventional use and sustainable valorization of spent egg-laying hens as functional foods and biomaterials: A review. Bioresources and Bioprocessing 9(1): 43. http://dx.doi.org/10.1186/s40643-022-00529-z

Fernandes E, Raymundo A, Martins LL, Lordelo M and de Almeida AM, 2023. The naked neck gene in the domestic chicken: a genetic strategy to mitigate the impact of heat stress in poultry production—a review. Animals 13(6): 1007. https://doi.org/10.3390/ani13061007

Gesek M, Michalska K and Murawska D, 2024. Effects of caponization and age on the histology, lipid localization and fibre diameter in muscles of Rhode Island Red cockerels. Polish Journal of Veterinary Sciences 27(4): 547-557. http://dx.doi.org/10.24425/pjvs.2024.152945

Gjøen J and Jensen P, 2024. Social preferences in chickens–effects of domestication and tameness. Frontiers in Animal Science 5: 1487688. https://doi.org/10.3389/fanim.2024.1487688

Govoni C, Chiarelli DD, Luciano A, Ottoboni M, Perpelek SN, Pinotti L and Rulli MC, 2021. Global assessment of natural resources for chicken production. Advances in Water Resources 154: 103987. https://doi.org/10.1016/j.advwatres.2021.103987

Guo X, Nan H, Shi D, Zhou J, Wan Y, Zhou B, Geng Z, Chen X and Jiang R, 2015. Effects of caponization on growth, carcass, and meat characteristics and the mRNA expression of genes related to lipid metabolism in roosters of a Chinese indigenous breed. Czech Journal of Animal Science 60(7): 327-333. http://dx.doi.org/10.17221/8279-CJAS

Han J, Kang HJ, Kim M and Kwon GH, 2020. Mapping the intellectual structure of research on surgery with mixed reality: Bibliometric network analysis (2000–2019). Journal of Biomedical Informatics 109: 103516. https://doi.org/10.1016/j.jbi.2020.103516

Henuk YL and Bakti D, 2018, October. Benefits of promoting native chickens for sustainable rural poultry development in Indonesia. In Talenta Conference Series: Agricultural and Natural Resources 1(1): 69-76. https://doi.org/10.32734/anr.v1i1.98

Hinsemu F, Hagos Y, Tamiru Y and Kebede A, 2018. Review on challenges and opportunities of poultry breeds. Journal of Dairy and Veterinary Sciences 7(2): 1-9. http://dx.doi.org/10.19080/JDVS.2018.07.555706

Hossen MI, Ritu WA, Rima UK, Rahaman T and Islam MS, 2021. Caponization and its effects on growth performance and chemical composition of meat in Sonali Birds. South Asian Journal of Biological Research 3(2): 75-86.

Kandeel M, Morsy MA, Abd El-Lateef HM, Marzok M, El-Beltagi HS, Al Khodair KM, Albokhadaim I, Venugopala KN, Al-Rasheed M and Ismail MM, 2023. A century of "anticoccidial drugs": bibliometric analysis. Frontiers in Veterinary Science 10: 1157683. http://dx.doi.org/10.3389/fvets.2023.1157683

Kumar S, Chavan M and Pandey N, 2023. Journal of International Management: a 25-year review using bibliometric analysis. Journal of International Management 29(1): 100988. http://dx.doi.org/10.1016/j.intman.2022.100988

Kwiecień M, Kasperek K, Winiarska-Mieczan A, Danek-Majewska A, Kwiatkowska K, Arczewska-Włosek A, Jarosz Ł and Zaricka E, 2019. Effect of caponisation on bone development in native male chickens. Annals of Animal Science 19(4): 991-1007. http://dx.doi.org/10.2478/aoas-2019-0057

Lawal RA, Martin SH, Vanmechelen K, Vereijken A, Silva P, Al-Atiyat RM, Aljumaah RS, Mwacharo JM, Wu DD, Zhang YP and Hocking PM, 2020. The wild species genome ancestry of domestic chickens. BMC Biology 18: 1-18. https://doi.org/10.1186/s12915-020-0738-1

Mahmud MA, Shaba P, Gana J, Yisa HY, Ndagimba R, Abdulsalam W, Ndagi S and Abubakar L, 2014. Osteometric effects of surgical caponisation on some long bones in cockerel chickens. Advances in Zoology 2014(1): 645071. https://doi.org/10.1155/2014/645071

Mengesha Y, Kebede, E and Getachew A, 2022. Review of chicken productive and reproductive performance and its challenges in Ethiopia. All Life 15(1): 118-125. https://doi.org/10.1080/26895293.2021.2024894

Murawska D, Gesek M and Witkowska D, 2019. Suitability of layer-type male chicks for capon production. Poultry Science 98(8): 3345-3351. https://doi.org/10.3382/ps/pez146

Nawab A, Ibtisham F, Li G, Kieser B, Wu J, Liu W, Zhao Y, Nawab Y, Li K, Xiao M and An L, 2018. Heat stress in poultry production: Mitigation strategies to overcome the future challenges facing the global poultry industry. Journal of Thermal Biology 78: 131-139. https://doi.org/10.1016/j.jtherbio.2018.08.010.

Nawaz AH, Setthaya P and Feng C, 2024. Exploring Evolutionary Adaptations and Genomic Advancements to Improve Heat Tolerance in Chickens. Animals 14(15): 2215. http://dx.doi.org/10.3390/ani14152215

Nkukwana TT, 2018. Global poultry production: Current impact and future outlook on the South African poultry industry. South African Journal of Animal Science 48(5):

869-884. http://dx.doi.org/10.4314/sajas.v48i5.7

Omar AM and Abdullahi MO, 2024. A bibliometric analysis of sustainable digital transformation in developing countries' higher education. In Frontiers in Education (9): 1441644. Frontiers Media SA. https://doi.org/10.3389/feduc.2024.1441644

Padhi MK, 2016. Importance of indigenous breeds of chicken for rural economy and their improvements for higher production performance. Scientifica 2016(1): 2604685. https://doi.org/10.1155/2016/2604685

Passas I, 2024. Bibliometric analysis: the main steps. Encyclopedia 4(2). https://doi.org/10.3390/encyclopedia4020065

Paudel TP, Poudel B and Neupane D, 2018. Evaluation of caponization on growth and meat quality parameters of dual-purpose chicken. International Journal of Applied Sciences and Biotechnology 6(4): 339-343. http://dx.doi.org/10.3126/ijasbt.v6i4.22113

Rejeb A, Simske S, Rejeb K, Treiblmaier H and Zailani S, 2020. Internet of Things research in supply chain management and logistics: A bibliometric analysis. Internet of Things 12: 100318. https://doi.org/10.1016/j.iot.2020.100318

Ren X, Guan Z, Li H, Zhang L, Wen J, Zhao X, Wang G, Zhang X, Wang H, Yu F and Chen Z, 2023. Phylogenetic analysis reveals multiple origins of Chinese gamecocks. Poultry Science 102(12): 103068. https://doi.org/10.1016/j.psj.2023.103068

Rikimaru K, Takahashi H and Nichols MA, 2011. An efficient method of early caponization in slow-growing meat-type chickens. Poultry Science 90(8): 1852-1857. https://doi.org/10.3382/ps.2010-01270

Ryad HM, Yadav SK, Bostami MB, Sutradhar BC and Das B, 2022. Effect of caponization on growth performance and blood parameter in Fayoumi cock. GSC Advanced Research Reviews 13: 105-115. https://doi.org/10.30574/gscarr.2022.13.1.0258

Senbeta DH and Keyata EO, 2024. Genetic diversity, gene conservation and indigenous-chicken gene erosion in Ethiopia: A Review. Journal of Agriculture, Food and Natural Resources 2(2): 49-54. http://dx.doi.org/10.3382/ps.2010-01270

Shao D, Yang Y, Shi S and Tong H, 2022. 3D organization of chicken genome demonstrates evolutionary conservation to extreme environments. Authorea Preprints. http://dx.doi.org/10.22541/au.166324198.83926878/v1

Shirin A, Nadia N, Hossain MS, Labony SS, Ritu SN, Ali MH, Islam UR, Parvin R, Esha SA, Dey AR and Alam MM, 2025. Cheilospirura hamulosa (Nematoda: Acuariidae) infection in indigenous chickens in Bangladesh: epidemiology, pathology and anthelmintic efficacy. Parasitology 2025: 1-8. https://doi.org/10.1017/S0031182025000319

Siegel PB, Honaker CF and Scanes CG, 2022. Domestication of poultry. In: Sturkie's Avian Physiology, pp: 109-120. Academic Press. https://doi.org/10.1016/B978-0-12-819770-7.00026-8

Singchat W, Chaiyes A, Wongloet W, Ariyaraphong N, Jaisamut K, Panthum T, Ahmad SF, Chaleekarn W, Suksavate W, Inpota M and Chaisongkram C, 2022. Red junglefowl resource management guide: Bioresource reintroduction for sustainable food security in Thailand. Sustainability 14(13): 7895. https://doi.org/10.3390/su14137895

Sukhija N, Kanaka KK, Goli RC, Kapoor P, Sivalingam J, Verma A, Sharma R, Tripathi SB and Malik AA, 2023. The flight of chicken genomics and allied omics-a mini review. Ecological Genetics and Genomics 29: 100201. https://doi.org/10.1016/j.egg.2023.100201

Susilo AYTB, Hanif MF, Ariyadi B, Putra ARS and Agus A, 2024. Research trends on cage-free housing system in laying hens: A bibliometric analysis. Advances in Animal and Veterinary Sciences 12(8): 1433-1441. http://dx.doi.org/10.17582/journal.aavs/2024/12.8.1433.1441

Symeon GK, Mantis F, Bizelis I, Kominakis A and Rogdakis E, 2012. Effects of caponization on growth performance, carcass composition and meat quality of males of a layer line. Animal 6(12): 2023-2030. https://doi.org/10.1017/S1751731112001024

Uyanga VA, Musa TH, Oke OE, Zhao J, Wang X, Jiao H, Onagbesan OM and Lin H, 2023. Global trends and research frontiers on heat stress in poultry from 2000 to 2021: A bibliometric analysis. Frontiers in Physiology 14: 1123582. https://doi.org/10.3389/fphys.2023.1123582

Volsche S, Wathan J, Abbas N, Kimwele LK, Capponi G, Ontillera-Sánchez RR, Zoubek E and Ramasawmy M, 2024. Cross-Cultural Variation in Human–Animal Interaction. In: Introduction to Human-Animal Interaction, pp: 79-94. Routledge. https://doi.org/10.4324/9781003221753

Wang C, Yang C, Zeng Y and Zhang M, 2023. GnRH-immunocastration: an alternative method for male animal surgical castration. Frontiers in Veterinary Science 10: 1248879. http://dx.doi.org/10.3389/fvets.2023.1248879

Wojciechowska-Puchałka J, Calik J, Krawczyk J, Obrzut J, Tomaszewska E, Muszyński S and Wojtysiak D, 2024. The effect of caponization on tibia bone histomorphometric properties of crossbred roosters. Scientific Reports 14(1): 4062. http://dx.doi.org/10.1038/s41598-024-54791-6

Yajie L, Johar MGM and Hajamydeen AI, 2023. Poultry disease early detection methods using deep learning technology. Indonesian Journal of Electrical Engineering and Computer Science 32(3): 1712-1723. https://doi.org/10.11591/ijeecs.v32.i3.pp1712-1723

Yaqoub M, Gao Z, Ye X, Al-Kassimi K, Chen Z and Haizhou W, 2023. Three decades of glocalization research: A bibliometric analysis. Cogent Social Sciences 9(2): 2245239. http://dx.doi.org/10.1080/23311886.2023.2245239

Ye F, Deng ZD, Liu KY, Yao XM, Zheng WX, Yin Q, Hai X, Gan JK, Zhang ZF, Ma Z and Li H, 2024. Integrative analysis of the transcriptome, proteomics and metabolomics reveals key genes involved in the regulation of breast muscle metabolites in capons. BMC Genomics 25(1): 1239. http://dx.doi.org/10.1186/s12864-024-11142-z

Zawacka M, Murawska D and Gesek M, 2017. The effect of age and castration on the growth rate, blood lipid profile, liver histology and feed conversion in Green-legged Partridge cockerels and capons. Animal 11(6): 1017-1026. https://doi.org/10.1017/s1751731116002378

Zaheer K, 2015. An updated review on chicken eggs: production, consumption, management aspects and nutritional benefits to human health. Food and Nutrition Sciences 6(13): 1208. http://dx.doi.org/10.4236/fns.2015.613127

Zhu D, Wang Y, Qu H, Feng C, Zhang H, Sheng Z, Jiang Y, Nie Q, Chu S, Shu D and Jiang Z, 2025. GCRP: Integrated Global Chicken Reference Panel from 11,951 Chicken Genomes. Genomics, Proteomics & Bioinformatics, p.qzaf032. https://doi.org/10.1093/gpbjnl/qzaf032