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Bibliometric Analysis of Feed Additives and Their Effects on Meat Quality in Broiler Production

Melis Yağlı[1,a], Gülay Demir[2,b], Hasan Eleroğlu[3,c]

[1]*Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, Sivas Cumhuriyet University, Türkiye*
[2]*Vocational School of Health Services, Sivas Cumhuriyet University, Türkiye*
[3]*Department of Plant and Animal Production, Sivas Technical Sciences Vocational School, Sivas Cumhuriyet University, Sivas, Türkiye*
[*]*Corresponding author*

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ABSTRACT

The aim of this study was to reveal the effects of feed additives used in broiler production on meat quality over the last two decades. Within the scope of the research, studies published between 2004 and 2024 addressing the relationship between feed additives and meat quality were evaluated using bibliometric analysis. In this context, the Scopus database was searched and VOSviewer software was utilized during the analysis process. The literature search was conducted using the keywords "broiler," "feed," "supplements," and "meat quality," and a total of 536 documents were included in the analysis. Biblioshiny and Excel software packages were used for data analysis. According to the annual evaluation based on keywords, the highest number of publications was recorded in 2012 with 13 articles. Citation analysis indicated that 2007 had the highest citation intensity rate at 104.67%. Examination of the country distribution revealed that China produced the highest number of publications in the field of broiler nutrition and meat quality. Kim I.H. was identified as the most productive author. In the journal-based evaluation, Poultry Science ranked first with 156 articles published between 2004 and 2014, followed by British Poultry Science with 46 articles and Tropical Animal Health and Production with 18 articles. Keyword analysis showed that "meat quality" was the most frequently studied concept. Nanjing Agricultural University was identified as the institution with the highest number of publications, while China was the country with the highest citation rate and the strongest international collaboration network. Collaboration networks particularly highlighted joint studies between China and Saudi Arabia. The most frequently used terms in the studies were "diet," "chickens," "animal feed," "dietary supplement," and "meat." This study was conducted to reveal the changes and developments over the years regarding the effects of feed additives on meat quality in broiler production and to identify the types and usage trends of additives affecting quality. The findings are expected to provide guidance for future research on feed additives and innovative approaches applicable to poultry production.

[a] yaglimelis@gmail.com https://orcid.org/0009-0003-0285-9994
[b] gulaydemir@cumhuriyet.edu.tr https://orcid.org/0000-0002-3916-7639
[c] eleroglu@cumhuriyet.edu.tr https://orcid.org/0000-0002-1032-9833

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Introduction

In recent years, the increasing consumer demand for poultry meat has led to a substantial rise in production volumes within the poultry industry. This increase has been associated with the economic affordability, easy accessibility, and nutritional advantages of chicken meat. In particular, chicken breast meat is considered a product compatible with healthy dietary trends due to its low fat, sodium, and cholesterol content (Cavani et al., 2009). Accordingly, broiler chickens have become the primary production material for meeting the growing demand.

With the expansion of broiler production, research has focused not only on increasing production efficiency but also on improving meat quality. Meat color, texture, water-holding capacity, juiciness, tenderness, aroma, and flavor are among the major quality attributes directly influencing consumer purchasing decisions and post-consumption satisfaction (Mir et al., 2017). To meet the increasing demand, significant advances have been achieved in genetic selection, nutritional strategies, and management practices. In this regard, while the average live weight and feed conversion ratio of 42-day-old broilers were approximately 602 g and 2.8, respectively, in 1957, current values have reached approximately 3278 g live weight and 1.55 feed conversion ratio at the same age (Choi et al., 2023). These developments are considered clear indicators of the genetic and nutritional improvements achieved in production efficiency.

Within nutritional strategies, feed additives are widely used to regulate intestinal functions, improve growth performance, and enhance meat quality (Collington et al., 1990). In addition to production performance parameters, studies aimed at improving quality traits that directly affect consumer perception have gained increasing importance. Quality is defined as the totality of characteristics determining the acceptability of a product by the consumer (Garvin, 1984). Meat quality is influenced by numerous factors, including pre- and post-slaughter practices, genetic background, age, and feeding programs (Pelicano et al., 2003).

For many years, the inclusion of antibiotics in poultry diets was reported to improve growth performance and suppress pathogenic microorganisms in broiler chickens (Stutz and Lawton, 1984; Gaskins et al., 2002). However, restrictions on the prophylactic use of antibiotics, particularly following regulations implemented in the European Union, accelerated research into alternative feed additives such as enzymes, probiotics, prebiotics, organic acids, and phytogenic compounds (Janardhana et al., 2009; Dahiya et al., 2006). Consequently, natural-origin feed additives have attracted increasing scientific attention due to their potential benefits on gut health, microbial balance, and production performance (Wei and Shibamoto, 2007; Herawati, 2010).

Phytobiotics (phytogenic feed additives) are defined as plant-derived extracts obtained from aromatic and medicinal plants possessing both functional and flavoring properties (Yeşilbağ, 2007). These compounds are generally produced through steam distillation or mechanical extraction methods and are referred to by terms such as volatile oils, essential oils, or aromatic oils (Yeşilbağ, 2007). The restriction of antibiotic growth promoters has substantially increased interest in phytogenic additives in poultry nutrition. Particularly, plant-derived compounds have been reported to support production performance through their antimicrobial and antioxidant activities (Windisch et al., 2008; Yang et al., 2009).

In antibiotic-free feeding programs, the inclusion of compounds with prebiotic properties in diets is considered an important strategy for maintaining intestinal microbiota balance and improving feed utilization efficiency. Among the most extensively studied prebiotics are fructo-oligosaccharides (FOS) and mannan-oligosaccharides (MOS) (Kim et al., 2011). Furthermore, dietary supplementation with aromatic plants such as thyme, mint, sage, and lavender has been reported to provide several advantages, including stimulation of appetite and digestive enzymes, enhancement of immune responses, and antimicrobial and antioxidant effects (Giannenas et al., 2018).

Another important group of feed additives commonly used in poultry nutrition is essential oils. These compounds are known for their digestive-supporting properties and exhibit antimicrobial effects through phenols, aldehydes, and terpenes that disrupt microbial cell membrane integrity (Kalemba and Kunicka, 2003; Di Pasqua et al., 2007). Plant sources such as thyme, mint, rosemary, sage, garlic, cinnamon, ginger, and clove are among the primary essential oil sources used in poultry diets (Adaszyńska-Skwirzyńska and Szczerbińska, 2017).

Antioxidants constitute another major feed additive group used in broiler diets. Antioxidants are generally classified as endogenous and exogenous compounds. Zinc, copper, selenium, and lycopene are considered exogenous antioxidants, whereas uric acid, melatonin, and albumin are examples of endogenous antioxidants (Gümüş and Küçükersan, 2017). Additionally, compounds such as vitamin E, ascorbic acid, β-carotene, glutathione, carnosine, and anserine are widely used natural antioxidants in poultry nutrition (Konyalıoğlu, 2001). Stress factors may impair oxidative balance and negatively affect meat quality; therefore, dietary antioxidant supplementation plays an important role in reducing oxidative damage and preserving meat quality (Çelebi et al., 2016).

The effects of feed additives in broiler nutrition are currently evaluated not only in terms of growth performance but also in relation to oxidative stability and post-mortem meat quality dynamics. Lipid and protein oxidation play critical roles in determining meat color stability, sensory properties, and shelf life (Raes et al., 2008; Delles et al., 2014). Poultry meat, particularly due to its high content of polyunsaturated fatty acids, is more susceptible to oxidative deterioration (Raes et al., 2008).

Dietary antioxidant additives have been reported to limit the formation of reactive oxygen species and support endogenous antioxidant enzyme systems, thereby reducing lipid peroxidation (Delles et al., 2014; Lu et al., 2014). Plant-derived phenolic compounds and phytobiotics have been shown to improve oxidative stability and decrease TBARS levels through their free radical scavenging capacities (Loetscher et al., 2013; Raes et al., 2008). Furthermore, combinations of polyphenols and α-tocopherol have been reported to enhance antioxidant capacity in meat under oxidative stress conditions (Mazur-Kuśnirek et al., 2019).

These findings demonstrate that the relationship between feed additives and meat quality should be evaluated not only through performance parameters but also within the framework of oxidative stress and metabolic regulation mechanisms. Indeed, the increasing frequency of terms such as “oxidative stress,” “lipid metabolism,” and “essential oils” in recent literature indicates that research trends are shifting toward a more mechanistic understanding of feed additive functions.

The aim of this study was to present a bibliometric analysis of studies investigating the effects of feed additives used in broiler production on meat quality. Bibliometric analysis is an analytical approach that enables the quantitative and statistical evaluation of scientific publications within a specific research field (Demir et al., 2022). To comprehensively evaluate the literature, the Scopus database was preferred due to its broad database coverage and extensive indexing capacity (Martín-Martín et al., 2018).

Importance and Purpose of the Study

This study aims to provide a bibliometric analysis of feed additives used in broiler production in response to the increasing poultry meat consumption and the growing demand for higher production efficiency, improved meat quality, and enhanced productivity. In recent years, a significant increase has been observed in research focusing on feed additives in poultry nutrition. Therefore, this analysis seeks to demonstrate the relationship between feed additives and meat quality through publication trends and bibliometric indicators. The positive effects of feed additives on both animal welfare and broiler development

are considered among the major factors contributing to the growing scientific interest in this field. The findings obtained from this bibliometric analysis are expected to contribute to future studies and provide guidance for innovative approaches in broiler production systems.

Research Questions

This study was designed to comprehensively evaluate the scientific literature through bibliometric analysis by examining publication trends, influential countries, highly cited articles, prominent authors, and journal productivity within the field. In this context, the following research questions were addressed:

- *Q1:* Which countries and authors have produced the highest number of publications on the effects of feed additives on meat quality in broiler production?
- *Q2:* What are the annual publication trends regarding the effects of feed additives on meat quality in broiler chickens?
- *Q3:* Which journals have published the highest number of studies on feed additives and meat quality in broiler production?
- *Q4:* What are the most frequently used keywords in studies investigating the effects of feed additives on meat quality in broiler chickens?
- *Q5:* Which universities and research institutions are the leading contributors in this research field?
- *Q6:* Which articles and authors have received the highest citation impact in studies related to feed additives and meat quality in broiler production?

This thesis is organized as follows. Section 2 presents the literature review and analysis of previous studies. Section 3 describes the materials and methods used in the bibliometric analysis. Section 4 provides the main bibliometric findings, research trends, and identified research gaps. Finally, the study concludes with discussion and conclusion sections.

Contributions of the Study

This bibliometric analysis focuses on the effects of feed additives on meat quality in broiler production. The study aims to contribute significantly to the understanding of the relationship between feed additives and changes in broiler meat quality. By systematically reviewing the available literature, this research provides a comprehensive evaluation of feed additive applications in broiler production through bibliometric analysis methods.

In this context, the study identifies feed additives that have been extensively investigated, highlights currently trending additives, and presents analytical findings related to broiler growth and meat quality. Based on these findings, the study is expected to guide future research by identifying underexplored topics and newly emerging trends in poultry nutrition and feed additive applications.

Research Gaps

Several major research gaps have been identified in studies investigating the use of feed additives in broiler production. One of the primary gaps is the limited understanding of the mechanisms of action of feed additives. Although many studies have examined the effects of feed additives on growth performance and meat quality, the molecular-level mechanisms and changes occurring in the intestinal microbiota have not yet been fully elucidated.

Another important gap concerns the long-term effects of feed additives. While feed additives are known to produce positive effects over short experimental periods, there is still insufficient information regarding their long-term impacts on animal health, performance, and product safety. In particular, the potential residue effects of feed additives remain an ongoing research topic.

The combined use of different feed additives represents another underexplored area. Studies investigating the synergistic or antagonistic interactions among various feed additives are still limited. Additionally, the effects of climatic and environmental factors have not been sufficiently addressed. Most studies have been conducted under controlled laboratory conditions, whereas investigations evaluating additive efficacy under different environmental conditions, particularly in regions exposed to heat stress, remain inadequate.

Finally, the interactions between novel alternative feed ingredients and conventional feed additives have not been comprehensively investigated. Addressing these research gaps may contribute to the more effective, sustainable, and scientifically optimized use of feed additives in broiler production systems.

Literature Review

The widespread use of antibiotics to enhance growth performance in poultry production was prohibited in many countries after the negative effects of these compounds on animal and human health became evident. Following these regulations, research focusing on alternative feed additives capable of replacing antibiotic growth promoters accelerated considerably. A bibliometric analysis conducted by Wickramasuriya et al. (2024) demonstrated that the United States has been a leading country in studies investigating antibiotic alternatives, with research predominantly focusing on broiler chickens. The same study also indicated that probiotics and phytogenic additives were among the most frequently investigated topics in this field.

Another major research area in broiler production is animal welfare. Cesari et al. (2024) presented a text-mining analysis addressing broiler welfare studies and reported a substantial increase in publication numbers over the last decade. These studies emphasized various production stages, including slaughtering methods, aimed at improving broiler welfare. Similarly, Dinasarki et al. (2024) investigated the effects of quality-related factors on the marketing performance of broiler products and concluded that feed efficiency and nutritional supplementation could play significant roles in improving marketing strategies.

Factors influencing growth performance in broiler chickens have also become a major focus of global research. Wu et al. (2024) evaluated the effects of diets supplemented with green walnut husk extract on meat quality and reported positive effects on gut health and meat development. Likewise, Banday et al. (2024) demonstrated that supplementation with *Malva sylvestris* leaf powder positively influenced growth performance, immune responses, and intestinal microbiota in broiler chickens.

Environmental factors also represent an important research topic in broiler production. Uyanga et al. (2023) reported that heat stress negatively affects growth performance, intestinal microbiota, and meat quality in broilers and predicted that future studies would increasingly focus on welfare practices and feed additives aimed at mitigating these adverse effects. In addition, the role of risk management and technological applications in poultry production has gained increasing importance. Sharif et al. (2023) reported a considerable increase in studies related to risks and technological innovations in poultry farming between 2002 and 2022, emphasizing that technological advancements are becoming increasingly important for reducing production risks.

Yardibi and Fırat (2021) examined research trends related to growth performance in animal production and revealed that the highest number of publications was recorded in 2010, with China emerging as the most productive country in this field. Their findings also indicated that studies primarily focused on broiler chickens, nutrient digestibility, and meat quality parameters. Mafruchati et al. (2022), on the other hand, analyzed studies investigating diseases and viral agents affecting embryonic development in broiler chickens and reported that genetic factors and viral infections constituted the primary research themes.

In another study conducted by Dinasarki et al. (2024), the effects of quality-related factors on marketing strategies in broiler production were comprehensively evaluated. Using the keywords "broiler chicken" and "marketing" within the Scopus database, the authors assessed the influence of housing conditions, feed efficiency, and nutritional supplementation on marketing performance. Their findings demonstrated that improvements in housing management, feed utilization efficiency, and appropriate supplementation strategies could positively influence marketing success.

Adnan et al. (2024) conducted another bibliometric study examining global research trends related to sorghum. Traditionally recognized as a feed crop, sorghum has recently gained attention for various alternative applications. Based on Scopus-indexed analyses, studies focusing on sorghum gene expression, responses to stress factors, grain productivity, biomass production, and metabolic processes were identified as prominent research areas. The authors emphasized that sorghum could make substantial contributions to future research, particularly in biomass production and feed efficiency.

In conclusion, the available literature demonstrates that interest in alternative feed additives capable of replacing antibiotics in poultry production has increased substantially in recent years. In addition, broiler welfare, meat quality, environmental stress factors, and marketing performance have emerged as major topics in current research. These studies collectively indicate that more efficient, sustainable, and high-quality broiler production systems are being targeted through the combined optimization of nutrition, genetics, environmental management, and technological applications.

Table 1 presents the bibliometric studies included in the literature review regarding the effects of feed additives on meat quality in broiler production.

Table 1. Bibliometric Analysis Studies on the Effects of Feed Additives on Meat Quality in Broiler Production

Authors	Year	Keywords	Time Period	NPE	D	Software Used
Mafruchati ve ark.	2024	Chicken, Embryo, Food security, Illness, Immunology	2008-2022	1348	1	Biblioshiny, VOSviewer
Dinasark ve ark.	2024	Broiler; Marketing, Stress management; Industry regulation, Retailer.	1963-2023	250	1	VOSviewer
Adnan ve ark.	2024	bibliometric analysis, content analysis, feed, food, bioenergy, sorghum, co-occurrence analysis	2019-2023	8,856	1	VOSviewer
Uyanga ve ark.	2023	bibliometric, chickens, growth performance, heat stress, oxidative stress, VOSviewer	2000-2021	684	2	VOSviewer
Sharif ve ark.	2023	Poultry farming risk; poultry farming industry, bibliometric analysis, Harzing's Publish or Perish; VOSviewer	2002-2022	477	1	VOSviewer
Yardibi ve ark.	2021	Bibliometric analysis, CiteSpace, growth performance, nutrient digestion, trend topic	2010-2020	10.240	2	CiteSpace
Cui ve ark.	2023	Farm animal welfare; China, research trends; research hotspots, research frontiers; Bibliometric analysis;	2008-2023	1215	2	CiteSpace
Oliveira ve ark.	2023	Embryos; feeding in ovo, hatching eggs; poultry production, VOSviewer	1985-2023	242	1	VOSviewer
Wickramasuriya ve ark.	2024	Alternative to the antibiotic, growth promoter, poultry, global trend, publication	2009-2022	2038	3	Rayyan
Singhal ve ark.	2024	Environmental enrichment, brain, rodents, hippocampus, learning, memory, behavior, cogniti	1967-2024	2385	1	VOSviewer, R Studio

NPE: Number of Publications Examined; D: Database; 1: Scopus; 2: Web Of Science;3: Scopus, Web of Science/InCites, and Dimensions

Materials and Methods

This study was conducted using the bibliometric analysis method. Bibliometric analysis is a discipline that focuses on the quantitative evaluation and analysis of scientific publications. This method is used to examine the communication patterns, interactions, and relationships among publications related to a specific topic through various filtering and analytical approaches (Demir et al., 2024). In the present study, the distribution of publications, the most highly cited articles, the most frequently used keywords, prominent authors, the most productive journals, international collaborations among countries, and keyword networks were evaluated.

Through bibliometric analysis, the study aims to provide guidance for future research based on previously published scientific studies. In addition, potential research gaps related to the effects of feed additives on meat quality in broiler production were identified.

The Scopus database was used to obtain the bibliographic data included in this study. After applying several filtering procedures to the retrieved articles, the data were analyzed sequentially using the Biblioshiny and VOSviewer software packages. The workflow of the study is also illustrated schematically below.

Figure 1 presents the bibliometric analysis flowchart illustrating the research process conducted using the keywords "broiler," "feed," "supplements," and "meat quality."

In this study, the Scopus database was selected as the data source. Scopus is widely used in bibliometric research due to its broad journal coverage across disciplines and its strong indexing capacity, particularly in the social sciences (Mongeon & Paul-Hus, 2016; Pranckutė, 2021). Compared with the Web of Science, both databases have similar core functions; however, Scopus has been reported to offer a wider journal coverage and to include a greater number of publications in certain fields (Singh et al., 2021). These characteristics support the suitability of Scopus as an appropriate data source for comprehensive literature review and citation-based analyses.

Table 2 presents the filtering process of the data retrieved from the Scopus database.

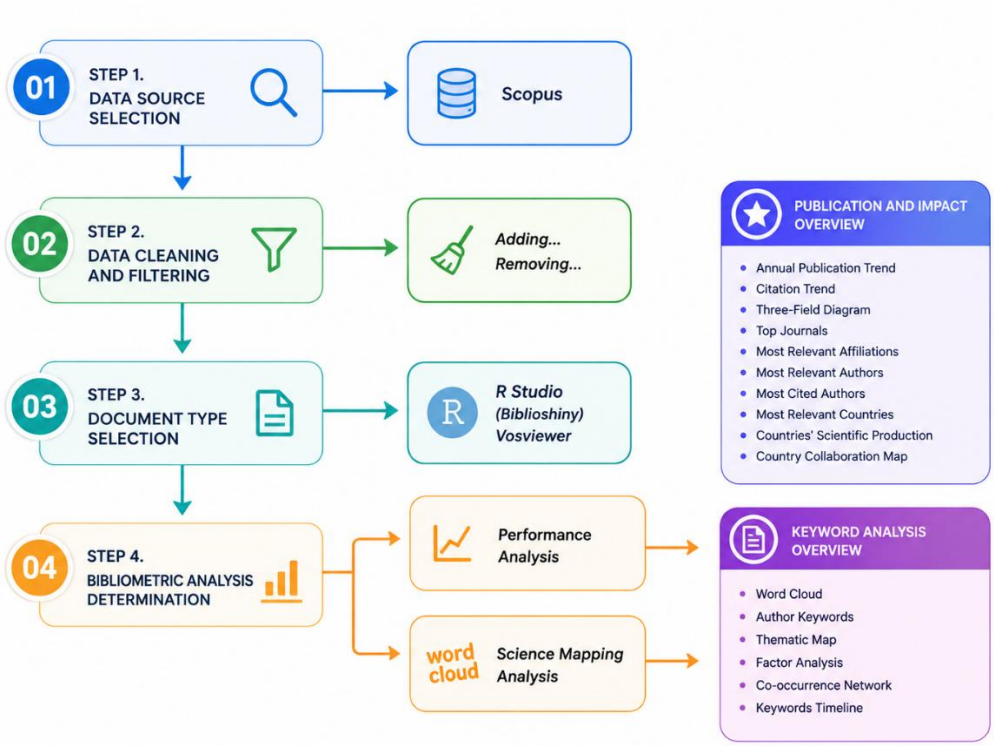

Figure 1. Bibliometric Analysis Flow Diagram

Table 2. Filtering of Data Retrieved from the Scopus Database

Category	Criteria
Included Criteria	Keywords: 'Broiler', 'feed', 'supplements', 'meat quality' Document type: Article Language: English Publication type: Journal articles Publication years: 2004–2024
Excluded Criteria	Preprints, web-based publications, review and conference papers Book chapters Commentaries, editorials, and letters

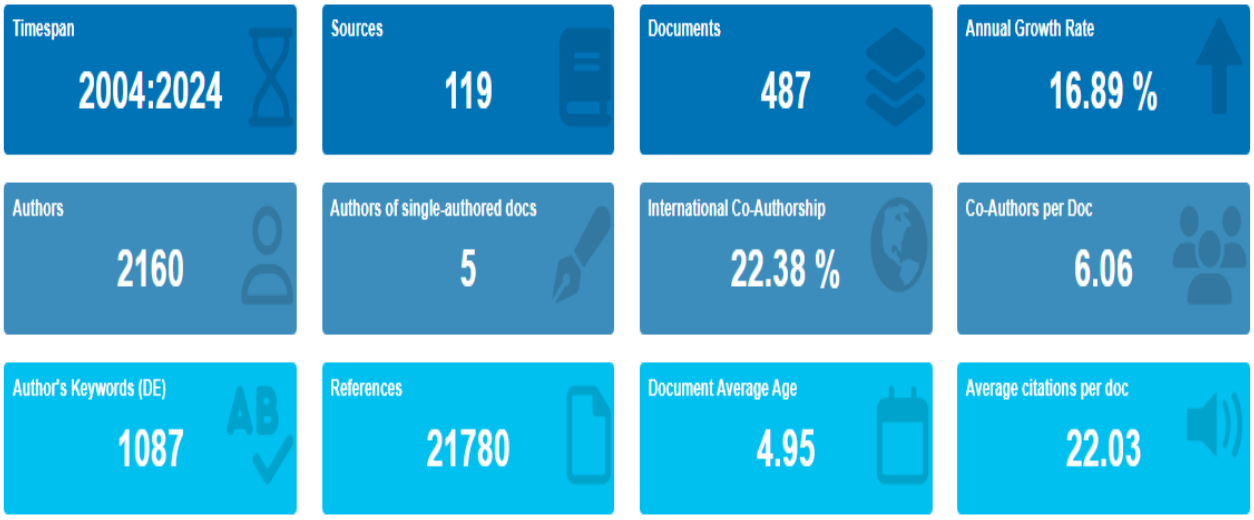

Figure 2. Main Information of the Bibliometric Analysis

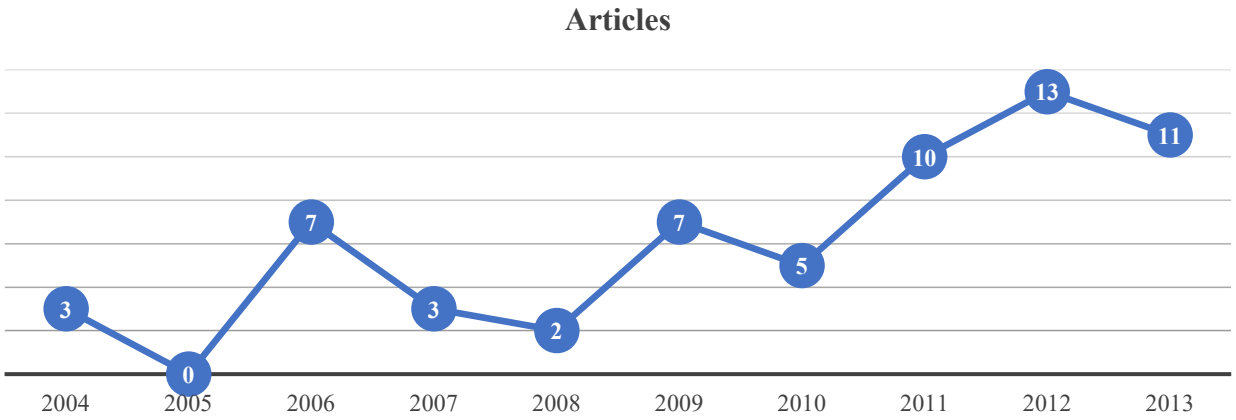

Figure 3. Annual Distribution of Publications

Bibliometric Analysis Results of Studies Related to 'Broiler', 'Feed', 'Supplements', and 'Meat Quality'

The dataset of this study was obtained through an advanced search conducted in the Scopus database. The search strategy was constructed using the query TITLE-ABS-KEY ("broiler" AND "supplements" AND "meat quality" AND "chicken"), which required the specified keywords to appear simultaneously in the title, abstract, and keyword fields of the publications.

An initial search covering the years 2004–2024 yielded a total of 536 records. After applying filtering criteria including publication language (English), document type (research articles), and removal of duplicate records, a final sample of 487 articles was obtained for analysis.

Performance Analysis

Figure 2 presents the main bibliometric indicators of the analysis.

Between 2004 and 2024, a total of 487 articles published in 119 journals were identified. A total of 2,160 authors contributed to studies indexed under the keywords 'broiler', 'feed', 'supplements', and 'meat quality', and 5 of these authors contributed as single authors. The annual growth rate of publications was found to be 16.89%, the rate of international co-authorship was 22.38%, and the average document age was 4.95 years.

Annual Publication Trends

The number of publications by year is presented in Figure 3.

As shown in Figure 3, within the 2004–2024 time period, 11 articles were published in 2013, 13 articles in 2012, and 10 articles in 2011 were contributed to the literature.

Citation Status

The number of citations received by the articles by year is shown in Figure 4.

The annual citation patterns of the publications show a varying trend according to the graph. It is observed that 67.67% of citations were made to publications in 2004, while a citation rate of 37.75% was recorded in 2014. This variation is likely associated with changes in research focus and the evolving nature of studies related to the keywords 'broiler', 'feed', 'supplements', and 'meat quality'.

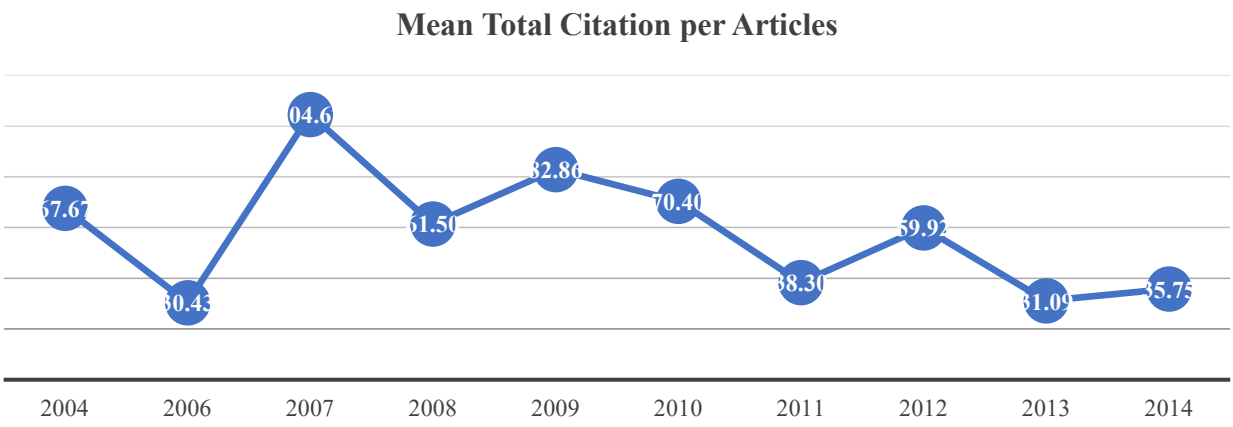

Figure 4. Citation Status

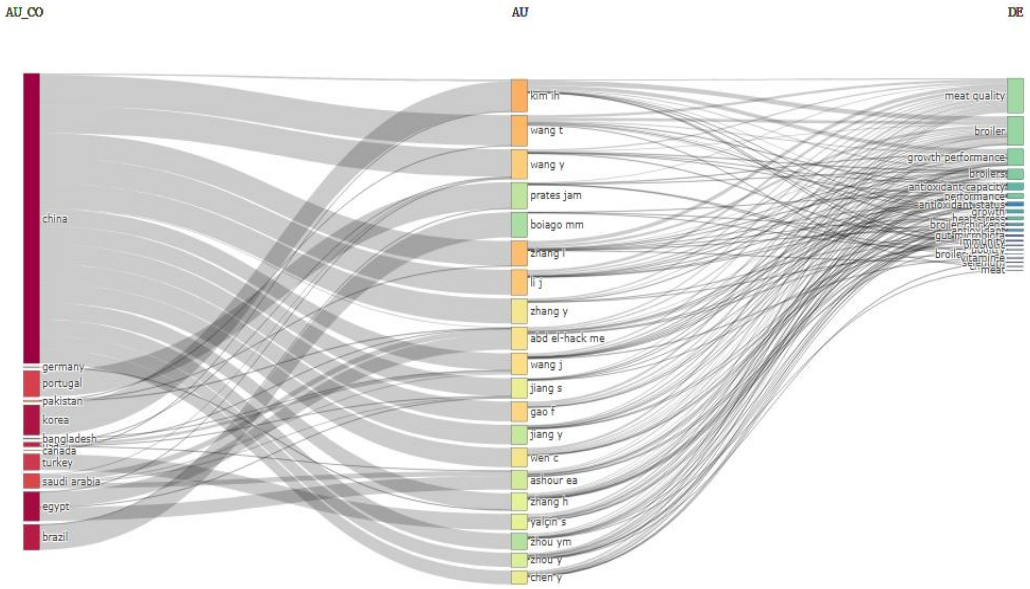

Figure 5. Three-Field Plot

Table 3. Most Productive Journals

Sources	Articles
Poultry Science	156
British Poultry Science	46
Tropical Animal Health And Production	18
Animals	16
Journal Of The Science Of Food And Agriculture	16
Journal Of Animal Physiology And Animal Nutrition	15
Animal	13
Journal Of Animal Science	11
Biological Trace Element Research	10
Animal Science Journal	7

Three-Field Plot

The three-field diagram, also known as the Sankey diagram in the literature, is presented in Figure 5.

In this three-field plot, also known as a Sankey diagram, three parameters were compared. Using the advantages provided by the Biblioshiny interface, authors, countries, and keywords were analyzed. The size of the rectangles in the diagram indicates the importance of each parameter within the analysis. The most prominent country was China, the most influential author was Kim I.H., and the most significant keyword was 'meat quality'

Most Important Journals

Table 3 presents the most important journals publishing research related to the keywords 'broiler', 'feed', 'supplements', and 'meat quality'.

In the 2004–2024 period, based on the analysis conducted using the keywords 'broiler', 'feed', 'supplements', and 'meat quality', *Poultry Science* ranked first with 156 articles, followed by *British Poultry Science* with 46 articles, and *Tropical Animal Health and Production* with 18 articles.

Most Important Universities

Table 4 presents the most important universities included in the study, listed in order of prominence.

Nanjing Agricultural University ranks first with 191 publications. *Dankook University* ranks second with 96 publications, while the *Institute of Animal Science* ranks third with 59 publications.

Most Important Authors

Table 5 presents the most prominent authors identified among the studies included in the analysis.

In the present study, the most influential authors were identified as follows: *Kim I.H.* ranked first with 29 publications, followed by *Wang T.* with 14 publications, and *Zhang L.* with 13 publications.

Most Cited Authors

Table 6 presents the most cited authors and their respective number of publications in order.

Based on the data presented in Table 5, the most cited authors are as follows: *Kim, I.H.* ranks first with 15 publications and 602 citations, followed by *Park, J.H.* with 6 publications and 280 citations, and *Fontes, C.M.G.A.* with 4 publications and 272 citations.

Most Cited Countries

Table 7 presents the countries with the highest number of citations, ranked accordingly.

As shown in Table 7, China ranks first with 3,154 citations, followed by Korea with 1,234 citations, and the United States of America in third place with 725 citations.

Most Cited Article

Table 8 presents the most cited articles, their authors, the journals in which they were published, and their citation counts.

Jiang et al. (2007), published in Poultry Science, ranked first with 195 citations for the article titled "Effects of soybean isoflavone on growth performance, meat quality, and antioxidation in male broiler chickens."

Jung et al. (2010), published in Meat Science, ranked second with 191 citations for the article titled "Effect of dietary mixture of gallic acid and linoleic acid on antioxidative potential and quality of breast meat from broiler chickens."

Hwangbo et al. (2009), published in Journal of Environmental Biology, ranked third for the article titled "Utilization of house fly-maggots, a feed supplement in the production of broiler chickens."

Word Cloud

The word cloud consisting of the most frequently used keywords in the studies is presented in Figure 7.

As shown in Figure 7, the frequency of the most commonly used keywords in the studies is represented proportionally by font size. Accordingly, the most frequently used keywords were diet, chickens, animal feed, dietary supplement, and meat.

Popular Topics

Table 9 presents the frequency of popular topics in this field according to years.

The term "meat" was identified as the most frequently used keyword, appearing 684 times in the first quarter of 2017, the second quarter of 2020, and the third quarter of 2022. The term "diet" ranked second, with 588 occurrences in the first quarter of 2018, the second quarter of 2020, and the third quarter of 2023. The term "male" ranked third, with 477 occurrences in the first quarter of 2017, the second quarter of 2020, and the third quarter of 2023. The term "Gallus gallus" remains actively used as of 2024.

Table 4. Most Important Universities

Affiliation	Articles
Nanjing Agricultural University	191
Dankook University	96
Institute Of Animal Science	59
Universidade De Lisboa	53
Zagazig University	43
China Agricultural University	42
Hunan Agricultural University	41
King Saud University	39
University Of Ilorin	34
Zhejiang University	33

Table 5. Most Important Authors

Authors	Articles	Articles Fractionalized
Kim I.H.	15	9.22
Wang T	14	2.14
Zhang L	13	2.19
Li J	12	1.98
Wang Y	11	1.39
Gao F	10	1.66
Wang J	10	1.77
Abd El-Hack Me	9	1.19
Wen C	9	1.37
Zhang Y	9	1.20

Table 6. Most Cited Authors

Authors	Articles	Number of Citations
Kim, I.H.	15	602
Park, J.H.	6	280
Fontes, C.M.G.A.	4	272
Prates, C.A.M	5	272
Wang, T.	6	260
Gao, F.	6	239
Zhou, Y.M.	7	223
Wang, tian	6	222
Zhang, L.	7	220

Table 7. Most Cited Countries

Country	Total Citations
China	3154
Korea	1234
Usa	725
Iran	599
Turkey	484
Portugal	269
Brazil	246
Belgium	221
Australia	182
Egypt	182

Table 8. Most Cited Articles

Paper	DOI	Total Citations
Jiang Zy, 2007, Poult Sci	10.1093/ps/86.7.1356	195
Jung S, 2010, Meat Sci	10.1016/j.meatsci.2010.06.007	191
Hwangbo J, 2009, J Environ Biol		183
Starčević K, 2015, J Sci Food Agric	10.1002/jsfa.6805	157
Michiels J, 2012, Poult Sci	10.3382/ps.2011-01585	151
Choct M, 2004, Brit Poult Sci	10.1080/00071660400006495	144
Delles Rm, 2014, Poult Sci	10.3382/ps.2013-03682	121
Liu X, 2012, Asian-Australas J Anim Sci	10.5713/ajas.2011.11334	120
Ponte Pip, 2008, Poult Sci	10.3382/ps.2007-00147	115
Sevcikova S, 2006, Czech J Anim Sci	10.17221/3964-cjas	115

Table 9. Popular Topics

Term	Frequency	Year (Q1)	Year (Q2)	Year (Q3)
Meat	634	2017	2020	2022
Diet	588	2018	2020	2023
Male	477	2017	2020	2023
Dietary supplement	304	2019	2021	2023
Chicken	278	2015	2019	2021
Veterinary medicine	209	2020	2022	2023
Metabolism	195	2016	2019	2021
Physiology	160	2016	2019	2022
Growth, development and aging	156	2014	2018	2020
Gallus gallus	137	2014	2023	2024

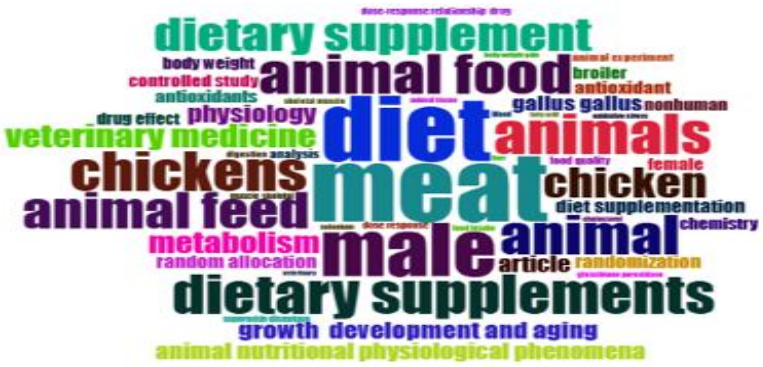

Figure 7. Word Cloud

Thematic Map of Author Keywords

The thematic mapping of authors' keywords is presented in Figure 8.

In the diagram, the clusters in the motor theme section represent the core research areas of the examined keywords. The clusters in the basic theme section indicate that the related keywords are in a fundamental structure and are undergoing transformation, meaning they represent developing and evolving research topics. The emerging or declining themes section shows newly emerging or decreasing keywords, while the niche themes section includes keywords that have been extensively studied but remain relatively isolated from other research areas.

Therefore, to understand which scientific areas the examined keywords are most strongly associated with, the basic and motor theme sections of the map should be primarily considered. In the motor theme, terms such as *phytobiotics*, *meat yield*, and *lipid metabolism* are observed. In the niche theme, *antioxidant*, *enzyme activity*, *creatinine nitrate*, and *amino acid* appear. In the emerging theme, *cholesterol*, *bioavailability*, and *TBARS* are identified, while in the basic theme, *n-3 fatty acids*, *sensory*, and *essential oils* are included.

Factor Analysis

Figure 9 presents the factor analysis constructed based on the keyword clusters used in the study.

Factor analysis is a statistical technique used to reduce the complexity of multivariate datasets and to reveal underlying latent structures. This method is applied to understand relationships among variables within a dataset and to make the data more interpretable and manageable. Factor analysis is generally expressed through coefficients known as factor loadings. Factor loadings indicate which variables are associated with which factors and which factors explain the commonality among specific variables.

According to the factor loadings, the red cluster includes the terms *blood*, *veterinary medicine*, and *Gallus gallus*. In the blue cluster, the terms *body weight*, *diet supplementation*, *animal tissue*, and *food intake* are included.

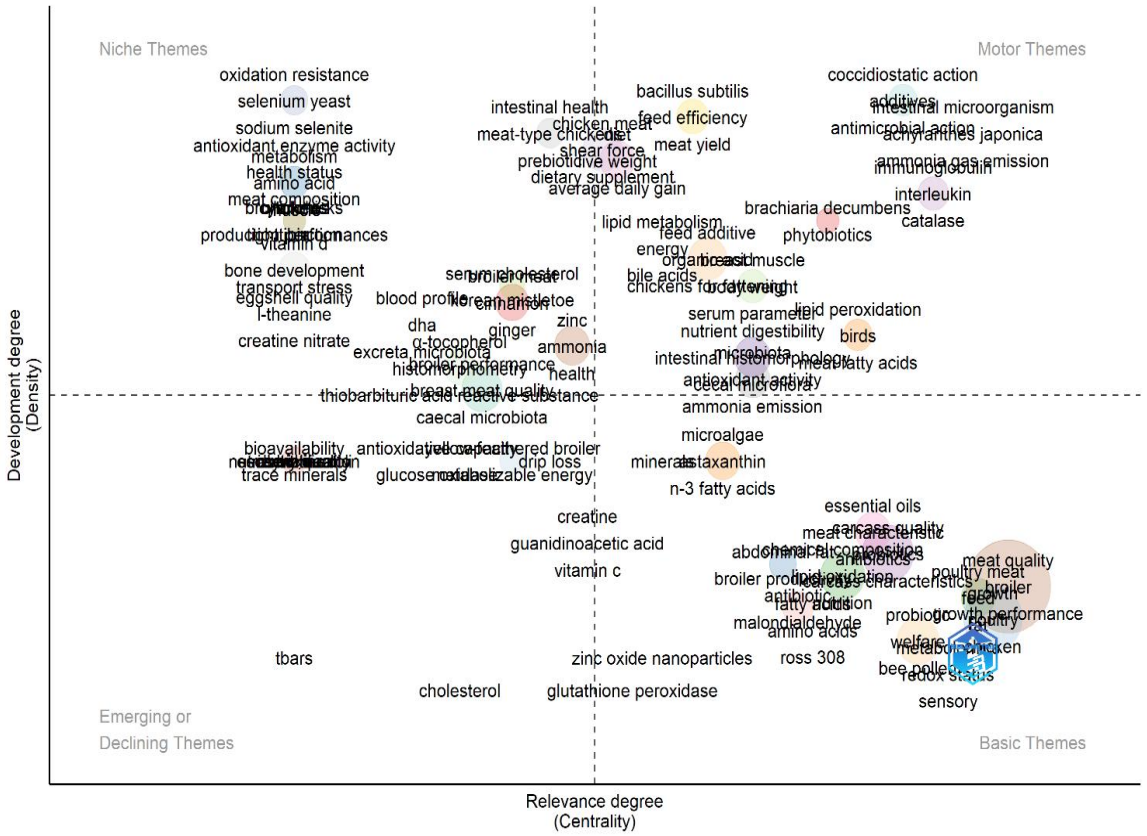

Figure 8. Thematic Map of Author Keywords

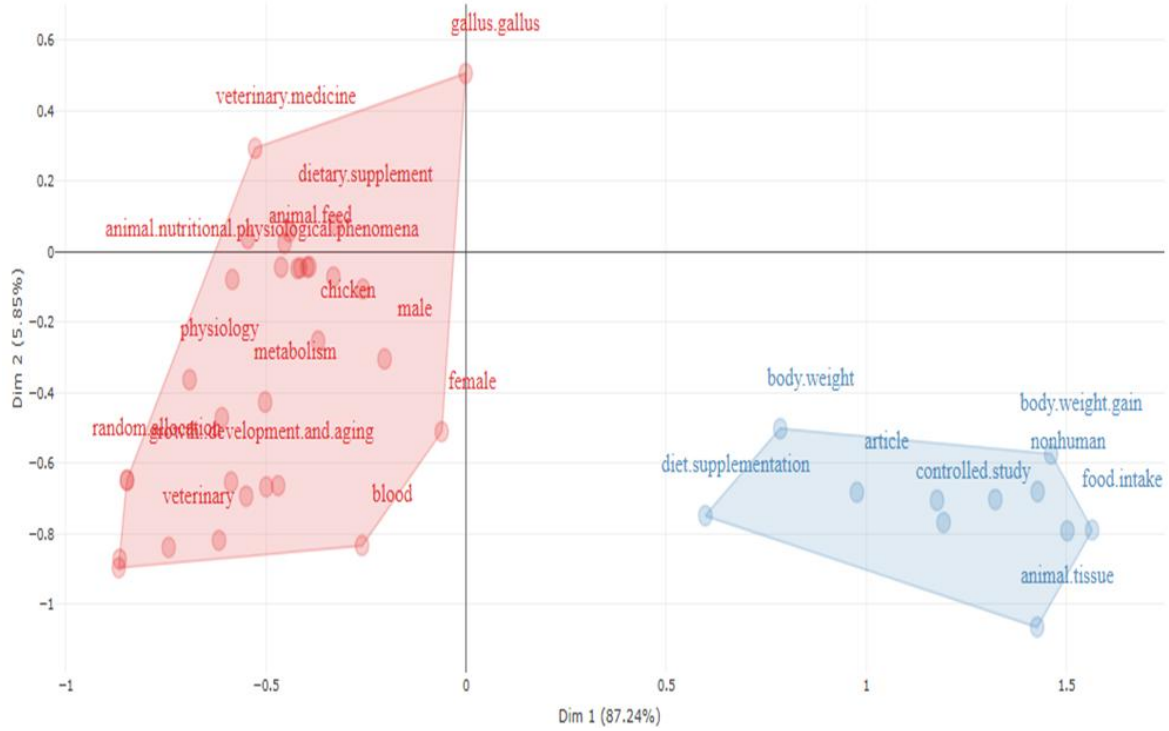

Figure 9. Factor Analysis

Country Collaboration Map

The countries that collaborated in the studies and their frequency of contributions are presented in both graphical and tabular form in Figure 10.

In the country collaboration map shown above, thick brown lines indicate a higher level of collaboration between countries, while thin brown lines represent lower levels of collaboration. Egypt and Saudi Arabia rank first among collaborating countries with 21 joint publications. Egypt and the United States rank second with 12 collaborations, while China and Egypt rank third with 6 collaborations. China is identified as the leading country in terms of international collaboration.

Network Map

The network map generated from the keywords is presented in Figure 11.

The keyword network map shown in Figure 11 consists of 12 clusters. Each color represents different keywords, indicating that various research topics have been addressed in the literature. Based on the analysis, the three most important keywords were identified as meat quality, broiler, and growth performance.

Timeline of Keywords

The keywords used according to their temporal distribution are presented in Figure 12.

As shown in Figure 12, the keywords feed additive, chicken meat, and feed have been studied more frequently. Keywords such as gut microbiota, broiler meat, carcass trait, lipid metabolism, and essential oils are still actively used in the literature.

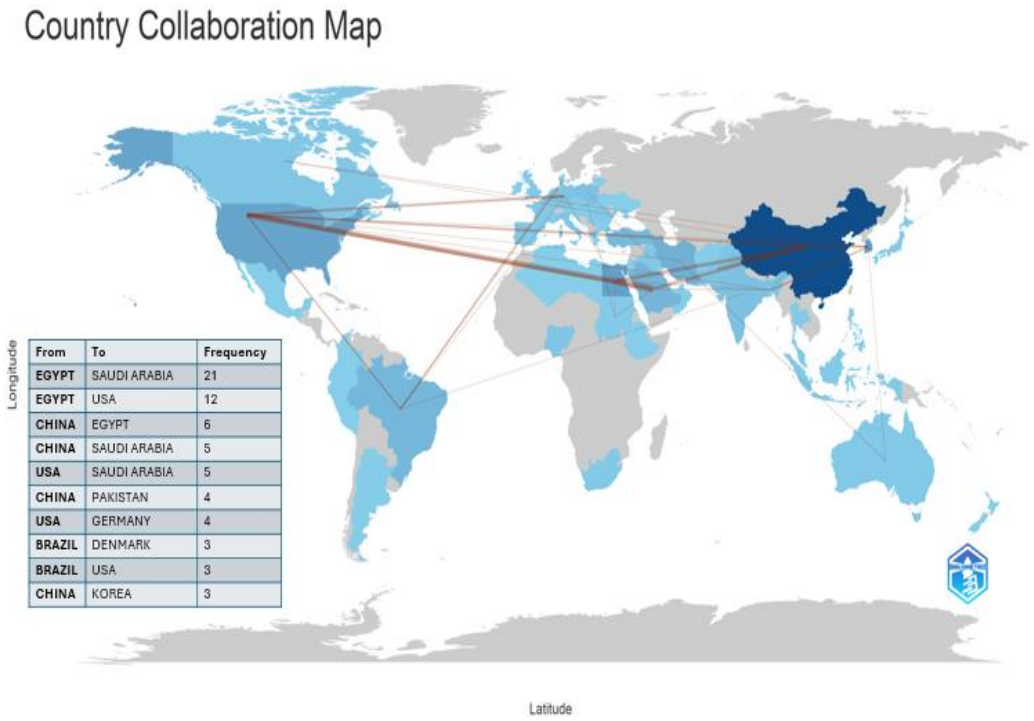

Figure 10. Country Collaboration Map

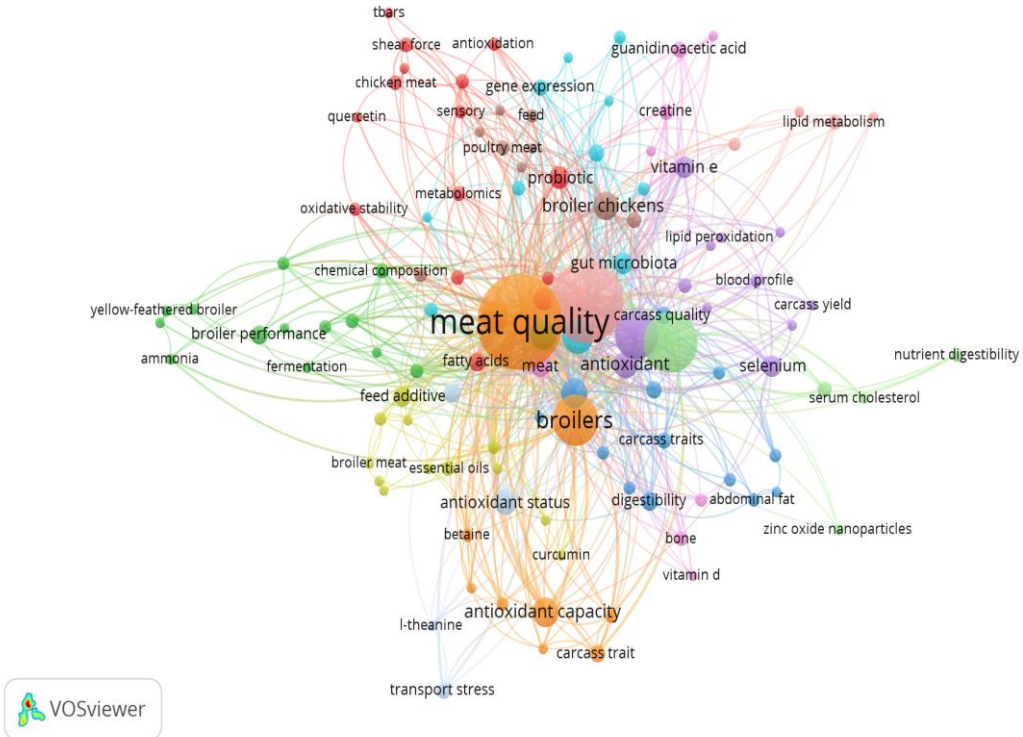

Figure 11. Network Map

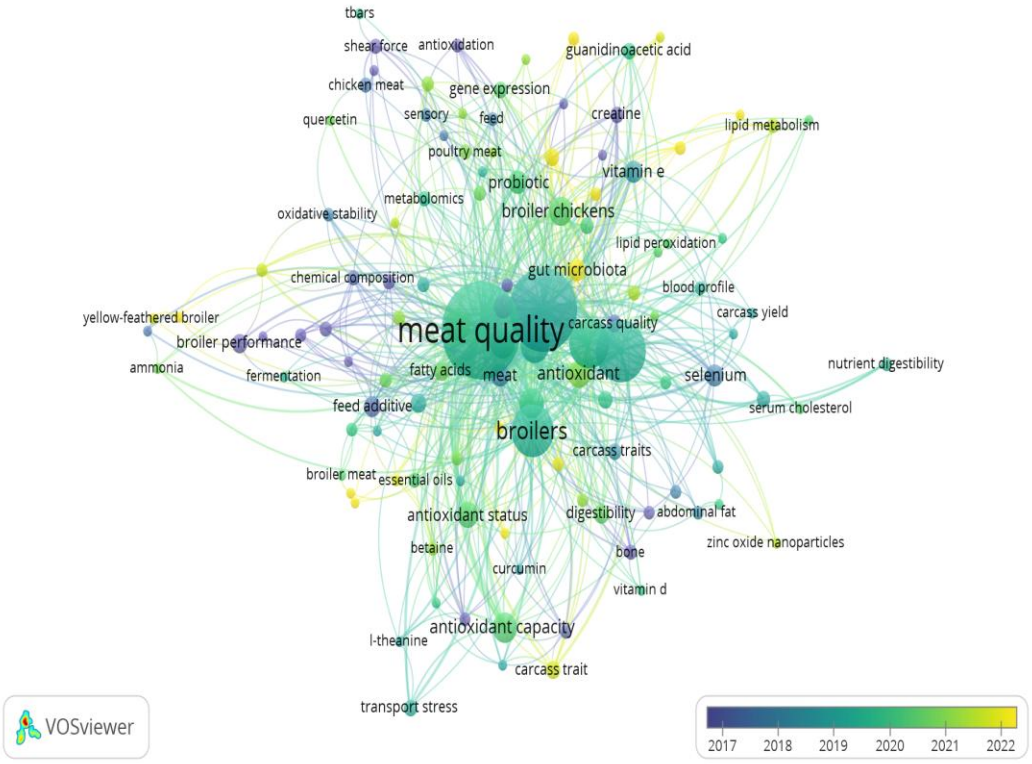

Figure 12. Timeline of Keywords

Discussion

The bibliometric analysis conducted in this study reveals that research on the relationship between feed additives and meat quality in broiler nutrition has intensified in recent years. The relatively low average age of publications indicates that the field is still in a developmental phase and methodological diversification is ongoing. This finding is consistent with previous bibliometric studies examining global trends in poultry science, which also report rapid expansion in functional feed additives and stress physiology research areas (Uyanga et al., 2023; Wickramasuriya et al., 2024).

The dominance of multi-authored publications suggests that the effects of feed additives are now addressed not only from a zootechnical performance perspective but also through the integration of disciplines such as biochemistry, microbiology, molecular biology, and food science. Similarly, Choi et al. (2023) emphasized that feeding strategies aimed at improving meat quality should be evaluated through multi-layered biological mechanisms. In addition, Mir et al. (2017) stated that meat quality cannot be explained solely by growth performance, but is strongly influenced by oxidative stability, muscle fiber characteristics, and metabolic regulation. In this context, the present bibliometric findings indicate a conceptual shift from performance-oriented approaches toward quality- and mechanism-oriented models.

The Three-Field Plot analysis indicates that China holds a dominant position in terms of productivity and citation impact, which is consistent with previous global publication trends reported by Uyanga et al. (2023) and Wickramasuriya et al. (2024). China's high share in global poultry production, research funding policies, and investment strategies in functional feed additives are considered key socio-economic drivers of this dominance. This suggests a direct relationship between scientific productivity and sectoral development.

Keyword clustering analysis shows that *meat quality* occupies a central position, clearly reflecting the thematic transformation in the literature. Petracci et al. (2015) and Mir et al. (2017) reported that meat quality parameters in fast-growing genotypes are critical for production strategies. Likewise, Delles et al. (2014) and Lu et al. (2014) demonstrated that dietary antioxidants improve meat stability by reducing lipid and protein oxidation. These findings highlight that feed additives are not only growth promoters but also quality modulators. The co-occurrence of *growth performance* and *meat quality* indicates that the balance between efficiency and quality has become a central research focus.

Timeline analysis shows that keywords such as *gut microbiota*, *lipid metabolism*, and *essential oils* have gained increasing importance in recent years, indicating a shift toward molecular and metabolic mechanisms. Tiihonen et al. (2010) and Kim et al. (2011) reported that essential oils and prebiotics can modulate gut microbiota, thereby influencing performance and immune responses. Furthermore, Raes et al. (2008) and Loetscher et al. (2013) demonstrated that natural antioxidant sources significantly improve oxidative stability in meat. Regulatory restrictions on antibiotic growth promoters (Erhan, 2016; Yeşilbağ, 2007) have also contributed to the increasing interest in phytobiotics and

natural alternatives. Therefore, this thematic shift is driven by both mechanistic and regulatory factors.

Factor analysis results indicate that the research field is structured around two main dimensions: biological/physiological responses and production performance indicators. This dual structure aligns with the holistic quality assessment approach emphasized by Mir et al. (2017) and Choi et al. (2023). The effects of feed additives are now evaluated not only through body weight gain but also through oxidative stress markers, muscle morphology (Tejeda et al., 2019), and gut microbiota composition.

Overall, the bibliometric evidence suggests that the field is undergoing both quantitative expansion and conceptual transformation. The literature is evolving from performance-centered production models toward quality-, sustainability-, and functional biology-based research paradigms. This transition highlights the need for future studies integrating omics technologies, biomarker-based quality indices, and interdisciplinary methodologies to enhance both theoretical and applied research value.

Conclusion

This study systematically examined the intellectual and thematic structure of the scientific literature on the relationship between feed additives and meat quality in broiler production using bibliometric methods. The analysis of Scopus-indexed publications within the selected keywords revealed not only quantitative growth but also a clear conceptual transformation in the field.

The findings demonstrate a shift from traditional production parameters such as growth performance and feed efficiency toward more complex quality determinants, including oxidative stability, lipid metabolism, and functional feed additives. The central position of *meat quality* and the increasing visibility of terms such as *essential oils*, *oxidative stress*, and *gut microbiota* indicate a growing scientific focus on molecular and metabolic mechanisms.

At the country and institutional level, China is identified as the dominant contributor, while journals such as *Poultry Science* serve as primary knowledge dissemination platforms. This indicates that scientific production is concentrated in specific geographical and institutional hubs, shaping global research networks.

This study provides a comprehensive framework by analysing thematic structures, collaboration networks, and citation patterns, thereby offering strategic insights for future research directions. In particular, comparative studies focusing on standardized quality indicators, oxidative biomarkers, and metabolic parameters may enhance methodological consistency. Moreover, increasing multidisciplinary research on the gut microbiota–metabolism–muscle quality axis will further strengthen the conceptual depth of the field.

However, the limitation of relying on a single database and predefined filtering criteria should be acknowledged. Future studies incorporating multiple databases, advanced network analysis techniques, and broader time ranges would provide a more comprehensive understanding of the intellectual structure of the field.

In conclusion, this bibliometric analysis moves beyond quantitative indicators and provides a conceptual and strategic perspective on the evolution of research linking feed additives and meat quality in broiler production, offering a guiding framework for both academic research and sustainable production strategies.

Original Contribution of the Study

This study presents a systematic bibliometric mapping of the relationship between feed additives and meat quality in broiler nutrition based on a specific keyword combination. While previous bibliometric studies have focused either on feed additives or performance parameters separately, integrated analyses combining feed additives with meat quality remain limited. In this respect, the study addresses an important gap in the literature.

The analysis extends beyond publication counts by examining countries, institutions, author networks, and thematic clusters, thereby providing a holistic view of the intellectual structure of the field. As a result, research trends, scientific impact, and development dynamics are evaluated within a unified framework.

This study therefore serves as a methodological reference for identifying future research priorities in the field of feed additives and meat quality in broilers.

Future Research Recommendations

Future studies are encouraged to focus on emerging keywords such as gut microbiota, broiler chicken meat, carcass traits, lipid metabolism, and essential oils, which are expected to contribute new insights to the literature.

Declarations

This study was presented at the IV. International Congress of the Turkish Journal of Agriculture - Food Science and Technology (Niğde, TURJAF 2025)

References

Adaszyńska-Skwirzyńska, Michalina, and Danuta Szczerbińska. "Use of essential oils in broiler chicken production – a review" Annals of Animal Science, vol. 17, no. 2, Sciendo, 2017, pp. 317-335. https://doi.org/10.1515/aoas-2016-0046

Adnan, A., Hastuti, C. O. I., Hadiarto, A., Lestari, I. P., Haryati, Y., Ariningsih, E., ... & Wijaya, A. (2024). Evolving Paradigms in Sorghum Research: A Bibliometric and Content Analysis of Global Trends and Future Directions. Journal homepage: http://iieta. Org/journals/ijdne, 19(3), 887-898.

Ay, F. A., Demir, G., & Karakaya, A. (2024). Mapping Futures Literacy: Bibliometric Analysis and Future Research Directions. Journal of Humanities and Tourism Research, 14(3), 414-437.

Banday, M. T., Wani, M. A., Alqhtani, H. A., Bin-Jumah, M., Rudayni, H. A., Allam, A. A., ... & Adil, S. (2024). Malva sylvestris leaf powder as a feed additive affects the performance, carcass traits, meat quality attributes, serum antioxidants, stress physiology, intestinal bacterial counts, and gut morphology of broiler chicken. Frontiers in Physiology, 15, 1462018.

Cavani, C., Petracci, M., Trocino, A., & Xiccato, G. (2009). Advances in research on poultry and rabbit meat quality. *Italian Journal of Animal Science, 8*(Suppl. 2), 741–750. https://doi.org/10.4081/ijas.2009.s2.741

Cesari, V., Gislon, G., Bava, L., & Toschi, I. (2024). Text mining approach in chicken meat welfare. Poultry Science, 103(12), 104349.

Choi, J., Kong, B., Bowker, B. C., Zhuang, H., & Kim, W. K. (2023). Nutritional Strategies to Improve Meat Quality and Composition in the Challenging Conditions of Broiler Production: A Review. Animals, 13(8), 1386. https://doi.org/10.3390/ani13081386

Collington, G. K., Parker, D. S., & Armstrong, D. G. (1990). The influence of inclusion of either an antibiotic or a probiotic in the diet on the development of digestive enzyme activity in the pig. *British Journal of Nutrition, 64*(1), 59–70. https://doi.org/10.1079/BJN19900008

Çelebi, Ş., Balcı, M. A., & Bozkurt, M. (2016). Broiler rasyonlarında antioksidan kullanımının et kalitesi üzerine etkileri. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi, 22*(Suppl. 1), S123–S130.

Çayan, H. (2018). Etlik piliç ve yumurta tavuklarında vejetaryen beslemenin performans, ürün kalitesi ve organoleptik özellikler üzerine etkileri.

Dahiya, J. P., Wilkie, D. C., Van Kessel, A. G., & Drew, M. D. (2006). Potential strategies for controlling necrotic enteritis in broiler chickens in post-antibiotic era. *Animal Feed Science and Technology, 129*(1–2), 60–88. https://doi.org/10.1016/j.anifeedsci.2005.12.003

Delles, R. M., Xiong, Y. L., True, A. D., Ao, T., & Dawson, K. A. (2014). Dietary antioxidant supplementation enhances lipid and protein oxidative stability of chicken broiler meat through promotion of antioxidant enzyme activity. Poultry Science, 93(6), 1561–1570. https://doi.org/10.3382/ps.2013-03682

Demir, G., & Arslan, R. (2022). Sensitivity Analysis in Multi-Criterion Decision-Making Problems. Ankara Hacı Bayram Veli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 24(3), 1025-1056. https://doi.org/10.26745/ahbvuibfd.1103531

Demir, G., Chatterjee, P., & Pamucar, D. (2024). Sensitivity analysis in multi-criteria decision making: A state-of-the-art research perspective using bibliometric analysis. *Expert Systems with Applications, 237*(Part C), 121660. https://doi.org/10.1016/j.eswa.2023.121660

Di Pasqua, R., Betts, G., Hoskins, N., Edwards, M., Ercolini, D., & Mauriello, G. (2007). Membrane toxicity of antimicrobial compounds from essential oils. Journal of Agricultural and Food Chemistry, 55(12), 4863–4870. https://doi.org/10.1021/jf0636465

Dinasarki, D., Tenrisanna, V., & Amrawaty, A. A. (2024). Broiler Product Quality: The Global Scientific Research Landscape and Implications for Marketing Performance. International Journal of Agriculture and Biosciences, 13(3), 306-312.

Eray, O., Alsan, İ., Filik, A. G., Filik, G. (2017). Antioksidanlara Genel Bir Bakış ve Kanatlı Hayvanlarda Kullanımı. Science and Technique in the 21st Century, 2(8), 25-36.

Erhan, M. K. (2016). Kanatlı Beslemesinde Antibiyotiklere Alternatif Olarak Kullanılan Bitki Ekstraktlarının Performans Değerleri ve Diğer Bazı Parametreler Açısından Değerlendirilmesi. Alinteri Journal of Agriculture Science, 28(1), 45-54.

G.-B. Kim, Y.M. Seo, C.H. Kim, I.K. Paik, (2011). Effect of dietary prebiotic supplementation on the performance, intestinal microflora, and immune response of broiler chickens, Poultry Science, Volume 90, Issue 1, Pages 75-82, https://doi.org/10.3382/ps.2010-00732.

Garvin, D. A. (1984). What does "product quality" really mean? *Sloan Management Review, 26*(1), 25–43.

Gaskins, H. R., Collier, C. T., & Anderson, D. B. (2002). Antibiotics as growth promotants: Mode of action. *Animal Biotechnology, 13*(1), 29–42. https://doi.org/10.1081/ABIO-120005768

Giannenas, I., Bonos, E., Skoufos, I., & Tzora, A. (2018). Effects of herbal feed additives on performance parameters, intestinal microbiota, intestinal morphology and meat lipid oxidation of broiler chickens. *British Poultry Science, 59*(5), 725–735. https://doi.org/10.1080/00071668.2018.1483577

Gümüş, E., & Küçükersan, S. (2017). Etlik piliç rasyonlarına doğal antioksidan ilavesinin performans, et pH değeri ile karaciğer ve kanda antioksidan aktiviteye etkisi. Veteriner Hekimler Derneği Dergisi, 88(2), 82-94.

Herawati. (2010). The effect of feeding red ginger as phytobiotic on body weight gain, feed conversion and internal organs condition of broiler. International Journal of Poultry Science, 9(10), 963–967. https://doi.org/10.3923/ijps.2010.963.967

Janardhana V, Broadway MM, Bruce MP, Lowenthal JW, Geier MS, Hughes RJ, Bean AG. Prebiotics modulate immune responses in the gut-associated lymphoid tissue of chickens. J Nutr. 2009 Jul;139(7):1404-9. doi: 10.3945/jn.109.105007. Epub 2009 May 27. PMID: 19474157.

K.-W. Lee, H. Everts, A.C. Beynen, 2004.Essential Oils in Broiler Nutrition.International Journal of Poultry Science,3:738-752.https://scialert.net/abstract/?doi=ijps.2004.738.752

Kalemba, D., & Kunicka, A. (2003). Antibacterial and antifungal properties of essential oils. Current Medicinal Chemistry, 10(10), 813–829. https://doi.org/10.2174/0929867033457719

Kim, G.-B., Seo, Y. M., Kim, C. H., & Paik, I. K. (2011). Effect of dietary prebiotic supplementation on the performance, intestinal microflora, and immune response of broilers. Poultry Science, 90(1), 75–82. https://doi.org/10.3382/ps.2010-00732

Konyalıoğlu, S. (2001). Et Kalitesi Üzerine Diyetle Alınan E Vitamininin Etkileri. Journal of Animal Production, 42(2). https://izlik.org/JA57YZ43RW

Loetscher, Y., Kreuzer, M., & Messikommer, R. E. (2013). Oxidative stability of broiler meat of birds supplemented with rosemary leaves, rosehip fruits, chokeberry pomace and nettle. Poultry Science, 92(11), 2938–2948. https://doi.org/10.3382/ps.2013-03258

Lu, T., Harper, A. F., Zhao, J., & Dalloul, R. A. (2014). Effects of a dietary antioxidant blend and vitamin E on growth performance, oxidative status, and meat quality in broiler chickens fed a diet high in oxidants. Poultry Science, 93(7), 1649–1657. https://doi.org/10.3382/ps.2013-03826

Mafruchati, M., Kusuma Wardhana, A., & Wan Ismail, W. I. (2022). Disease and viruses as negative factor prohibiting the growth of broiler chicken embryo as research topic trend: a bibliometric review. F1000Research, 11, 1124.

Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado López-Cózar, E. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics, 12*(4), 1160–1177. https://doi.org/10.1016/j.joi.2018.09.002

Mazur-Kuśnirek, M., Antoszkiewicz, Z., Lipiński, K., Kaliniewicz, J., & Kotlarczyk, S. (2019). The effect of polyphenols and vitamin E on the antioxidant status and meat quality of broiler chickens fed low-quality oil. Agriculture, 62(No. 287). https://doi.org/10.5194/aab-62-287-2019

Mir NA, Rafiq A, Kumar F, Singh V, Shukla V. Determinants of broiler chicken meat quality and factors affecting them: a review. J Food Sci Technol. 2017 Sep;54(10):2997-3009. Doi: 10.1007/s13197-017-2789-z. Epub 2017 Aug 28. PMID: 28974784; PMCID: PMC5603000.

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics, 106*(1), 213–228. https://doi.org/10.1007/s11192-015-1765-5

Ogbuewu IP, Okoro VM, Mbajiorgu CA. Meta-analysis of the influence of phytobiotic (pepper) supplementation in broiler chicken performance. Trop Anim Health Prod. 2020 Jan;52(1):17-30. doi: 10.1007/s11250-019-02118-3. Epub 2019 Nov 9. PMID: 31707686.

Omar, J. A., Hejazi, A., & Badran, R. (2016). Performance of broiler chickens supplemented with natural herb extract. Open Journal of Animal Sciences, 6(1), 68-74.

Pelicano, ERL & de, Souza & de, Souza & Oba, Alexandre & Norkus, EA & Kodawara, LM & de, Lima. (2003). Effect of different probiotics on broiler carcass and meat quality. Revista Brasileira de Ciência Avícola. 5. 10.1590/S1516-635X2003000300009.

Petracci, M., Mudalal, S., Soglia, F., & Cavani, C. (2015). Meat quality in fast-growing broiler chickens. World's Poultry Science Journal, 71(2), 363-374. https://doi.org/10.1017/S0043933915000367

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications, 9*(1), 12. https://doi.org/10.3390/publications9010012

Raes, K., De Smet, S., & Huyghebaert, G. (2008). Lipid and protein oxidation of broiler meat as influenced by dietary natural antioxidant supplementation. Poultry Science, 87(8), 1682–1688. https://doi.org/10.3382/ps.2007-00384

Sharif, K. I. M., Omar, M., Noor, M. D. M., Ismail, M. A., Hassan, M. G., & Gilal, A. R. (2023). A Bibliometric Analysis of Research on Risks in the Poultry Farming Industry: Trends, Themes, Collaborations, and Technology Utilization. International Journal of Advanced Computer Science and Applications, 14(7).

Singh, V. K., Singh, P., Karmakar, M., Leta, J., & Mayr, P. (2021). The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. *Scientometrics, 126*(6), 5113–5142. https://doi.org/10.1007/s11192-021-03948-5

Stutz, M. W., & Lawton, G. C. (1984). Effects of diet and antimicrobials on growth, feed efficiency and intestinal Clostridium perfringens in broiler chicks. *Poultry Science, 63*(10), 2036–2042. https://doi.org/10.3382/ps.0632036

Tejeda OJ, Calderon AJ, Arana JA, Meloche KJ, Starkey JD. Broiler chicken myofiber morphometrics and myogenic stem cell population heterogeneity1,2. Poult Sci. 2019 Sep 1;98(9):4123-4130. Doi: 10.3382/ps/pez287. PMID: 31144722.

Tiihonen K, Kettunen H, Bento MH, Saarinen M, Lahtinen S, Ouwehand AC, Schulze H, Rautonen N. The effect of feeding essential oils on broiler performance and gut microbiota. Br Poult Sci. 2010 Jun;51(3):381-92. doi: 10.1080/00071668.2010.496446. PMID: 20680873.

Uyanga, V. A., Musa, T. H., Oke, O. E., Zhao, J., Wang, X., Jiao, H., ... & 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.

Wei, A., & Shibamoto, T. (2007). Antioxidant activities and volatile constituents of various essential oils. *Journal of Agricultural and Food Chemistry, 55*(5), 1737–1742. https://doi.org/10.1021/jf062959x

Wickramasuriya, S. S., Ault, J., Ritchie, S., Gay, C. G., & Lillehoj, H. S. (2024). Alternatives to antibiotic growth promoters for Poultry: A bibliometric analysis of the research journals. Poultry Science, 103987.

Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science, 86*(E. Suppl.), E140–E148. https://doi.org/10.2527/jas.2007-0459

Wu, Y., Zhai, S., Fang, M., Zhang, H., & Chen, Y. (2024). Evaluation of the growth performance, meat quality, and gut microbiota of broilers fed diets containing walnut green husk extract. Poultry Science, 103(11), 104176.

Yang, Y., Iji, P. A., & Choct, M. (2009). Dietary modulation of gut microflora in broiler chickens: A review of the role of six kinds of alternatives to in-feed antibiotics. *World's Poultry Science Journal, 65*(1), 97–114. https://doi.org/10.1017/S0043933909000087

Yardibi, F., & Fırat, M. (2021). A bibliometric analysis of publications during the last decade on growth performance in animal science. Hayvansal Üretim, 62(2), 99-108.

Yeşilbağ, D. (2007). Fitobiyotikler. Uludağ Üniversitesi Veteriner Fakültesi Dergisi, 26(1-2), 33-39.