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ORIGINAL RESEARCH PAPER

SCIENTOMETRIC MAPPING OF RESEARCH CONCERNING THE IMPACT OF SOME TECHNOLOGIES IN THE POULTRY INDUSTRY ON THE NUTRITIONAL QUALITY OF MEAT. CASE STUDY: LIGHT SOURCES AND PHOTOPERIOD IN BROILER PRODUCTION

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Abstract: In modern poultry meat production, photoperiod regimes and lighting technologies represent critical environmental determinants that directly influence the performance and physiology of broiler chickens. This paper examines the scientific interest in the effects of these factors on growth, carcass traits, and health status using a scientometric approach. The data, collected from the Web of Science database using Boolean search queries, were analyzed with the Bibliometrix package and the Biblioshiny platform in R. In total, 7,421 publications were examined, allowing the assessment of research output, influential authors, leading journals, co-citation networks, and major research themes. The results reveal a substantial increase in scientific interest in the field and indicate a coherent interdisciplinary structure. These findings provide a robust foundation for future research and for the optimization of lighting strategies and photoperiod regimes in commercial poultry production.

Keywords: *bibliometrix, broiler performance, carcass characteristics, health status, light source, lighting system, meat quality, photoperiod, scientometric analysis, Web of Science*

INTRODUCTION

The poultry industry is one of the most dynamic and technologically advanced branches of modern agriculture, playing an essential role in meeting the global demand for animal-based food products.

Global poultry meat production has expanded steadily over recent decades, driven by rapid urbanization, population growth, and growing consumer demand for affordable and nutritious sources of protein [1, 2]. In this context, the implementation of technologies and farming practices that optimize productive efficiency, while ensuring animal welfare and maintaining high meat quality standards, becomes essential [3, 4]. One of the environmental factors with a major influence on the development of broiler chickens is artificial lighting, both in terms of the nature of the light source and the duration of exposure. Recent research highlights that light parameters can modulate fundamental processes in poultry organisms - metabolism, feeding behavior, locomotor activity, and physiological mechanisms - with direct effects on growth rate, feed conversion, carcass quality, and health status [5, 6].

Consequently, optimizing lighting strategies represents a promising direction for improving zootechnical performance in commercial farms.

In current practice, two types of light sources are predominantly used: light-emitting diodes (LEDs) and incandescent bulbs (IL).

LEDs have become increasingly widespread due to their low energy consumption, increased durability, and the possibility of adjusting the light spectrum according to the physiological needs of birds [7, 8].

In contrast, incandescent lighting, although traditional, proves to be less energy efficient and raises questions about its impact on behavior and metabolic functions [9 – 11].

Recent studies have shown that the type of light source not only affects the growth and welfare of birds but also has measurable effects on the chemical composition of broiler meat. Exposure to LED lighting, compared with traditional incandescent light, has been associated with an increase in protein content in the breast muscle and a reduction in intramuscular fat, suggesting superior nutritional quality [12, 13]. Additionally, LED illumination can enhance the levels of bioactive compounds, including antioxidants and polyunsaturated fatty acids (PUFAs), contributing to improved oxidative stability and overall meat quality [13, 14]. In contrast, incandescent lighting, while adequate for maintaining growth, has shown less pronounced effects on these parameters, with some studies reporting lower levels of amino acids and bioactive lipids [15], highlighting the potential benefits of optimizing light source selection in commercial production systems. These observations emphasize the importance of choosing the appropriate light source not only to enhance zootechnical performance but also to optimize the nutritional and functional quality of broiler meat.

In addition to the type of light source, photoperiod is an essential determinant of circadian rhythm, contributing to the regulation of biological processes involved in growth, metabolism, and physiological functions in broiler chickens [16]. The most commonly used light regimes - 12L:12D and 24L:0D - have specific advantages and limitations, which is why their analysis in relation to productive performance and animal welfare is indispensable [17, 18].

In this regard, it is imperative to understand how different lighting technologies and photoperiod regimes affect these parameters so that we can make effective recommendations for optimizing growth processes.
To demonstrate the relevance of the topic in the scientific community, a theoretical approach based on the Boolean query model was used, applied in the Web of Science database [19]. This procedure allowed the identification of the field's position in the international specialized literature.
The data set obtained was subjected to a scientometric analysis using the Bibliometrix package in R and the Biblioshiny platform, tools that facilitated the mapping of research developments, the analysis of co-citation networks, and the identification of the most influential publications in the field.
The results obtained provided a comprehensive overview of the current state of knowledge and served as a starting point for the development of further experimental directions. We believe that our approach contributes to a deeper understanding of how lighting and photoperiod shape the performance of modern poultry systems and provides the necessary foundation for identifying practical solutions aimed at optimizing production and improving meat quality in commercial farms.

MATERIALS AND METHODS

Justification of methodological originality

The methodological approach applied in this study is distinguished by the combination of Boolean queries in the Web of Science database with detailed scientometric analysis performed using the Bibliometrix package in R. This strategy is not limited to the mere collection and inventory of scientific literature but allows for the identification, critical evaluation, and multidimensional correlation of relevant studies, providing an integrated perspective on the evolution of knowledge in the field. The originality of the method lies in its ability to highlight not only general trends and the main contributions of authors and institutions but also the conceptual structure of the domain through co-citation and keyword co-occurrence analysis. In this way, the study offers a rigorous, objective, and up-to-date synthesis, identifying knowledge gaps and emerging research directions, thereby providing significant added value compared to traditional literature review methods.

Reasons for choosing the Boolean search method in Web of Science

The main objective of our approach was to identify and thoroughly analyze the level of interest shown in the specialized literature on the topics investigated. To this end, we sought to select, filter, and critically evaluate relevant articles, studies, and scientific materials in order to rigorously demonstrate the relevance and importance of the subject under analysis.
To collect the literature, we relied on the Boolean search method in the Web of Science Core Collection database, considering its ability to provide access to an extensive, updated, and validated corpus of scientific publications, with the search conducted in

April 2025. The use of logical operators (AND, OR, NOT) allows for the formulation of precise queries, the optimization of results, and the clear delimitation of relevant studies, eliminating materials that do not correspond to the objectives of the investigation.
This method facilitates the integration and correlation of distinct concepts, ensuring a coherent mapping of the literature and an appropriate selection of works addressing multidimensional themes, which is essential for achieving a current and comprehensive synthesis [20].
In accordance with the study's analysis guidelines, the search process was structured around three major thematic axes: growth performance, carcass characteristics, and health status. For each theme, pairs of relevant keywords were selected, configured as follows:

- “Light Source” AND “Broiler Performance” - to assess the influence of light sources on the productive performance of broiler chickens;
- “Photoperiod” AND “Carcass Characteristics” - to investigate the effect of photoperiod on carcass quality and composition;
- “Lighting System” AND “Health Status” - to examine the impact of lighting systems on health status and welfare.

The application of this method allowed for:

- rapid identification of studies with a high degree of specificity;
- elimination of irrelevant information through logical filtering;
- analysis of correlations between thematic variables and configuration of an integrated picture of the literature.

The results obtained formed the basis for a rigorous selection of studies and highlighted the need for in-depth research on the interaction between lighting, photoperiod, and productive and physiological parameters. Thus, Boolean search represents the solid methodological basis for the construction of the theoretical synthesis presented in this chapter.

Justification for choosing scientometric analysis for the pair "Light Source" AND "Broiler Performance"

Scientometric analysis was applied to the keyword pair "Light Source" AND "Broiler Performance," as this most accurately reflects the central objective of the research: evaluating how light sources influence the productive performance of broiler chickens. Given the major relevance and emerging nature of this topic, a scientometric approach provides a comprehensive picture of the evolution of knowledge in the field.
This method allows for the examination of indicators such as:

- the volume of publications dedicated to the relationship between light source and growth performance;
- the temporal dynamics of scientific interest;
- the main contributions of authors, institutions, and journals in the field;
- the conceptual structure of the field through the analysis of keyword co-occurrence.

Through aggregating and interpreting these elements, scientometric analysis facilitates the identification of dominant trends, knowledge gaps, and future research directions. In this way, the process is not limited to inventorying the literature, but generates a critical and organized perspective on existing scientific output.

Data analysis

Data analysis was performed using the Rgui platform with the Bibliometrix package, a popular tool for bibliometric analysis and visualization of scientific literature data. This package allows for the collection, processing, analysis, and graphical representation of a large volume of bibliographic data, providing a detailed overview of research trends, international collaborations, and the impact of various works on the field of interest. The analysis process comprised several essential steps:

Data collection

The data was extracted from Web of Science based on the query "Light Source" AND "Broiler Performance," identifying 7,421 papers published over a period of 50 years. This volume of information ensures high representativeness for a robust analysis.

Data preprocessing

The dataset was imported into R and subjected to a preprocessing stage that included:

- removing duplicate records;
- standardizing metadata;
- verifying the completeness of bibliographic fields.

This procedure ensured that a coherent and adequate set was obtained for further analysis.

Descriptive analysis

The descriptive analysis focused on elements such as:

- the temporal distribution of publications;
- the most cited authors;
- high-impact journals;
- countries and institutions with significant contributions.

The graphs and tables generated allowed for the characterization of general trends and collaboration networks.

Co-citation and keyword analysis

This stage aimed to identify thematic clusters and relationships between the concepts analyzed. Co-citation analysis highlighted the core authors and influence structures, while keyword analysis allowed the detection of emerging themes and their evolution over time.

Data visualization

The results were represented graphically by:

- concept maps;
- maps of collaboration between authors and institutions;
- temporal evolution diagrams.

These visualizations contributed to an intuitive and coherent interpretation of the data, strengthening the basis for the research conclusions.

RESULTS AND DISCUSSION

Statistical data from scientometric analysis

Data collection was conducted using the Web of Science Core Collection database. The Boolean search query “Light Source” AND “Broiler Performance” was applied to retrieve

publications addressing the relationship between lighting conditions and broiler production outcomes. The search yielded a set of relevant records, which were subsequently used as the dataset for the scientometric analysis and are summarized in Table 1.

Table 1. *Statistical data of the scientometric analysis*

Documents	7140 of 7140
Source	2497 of 2497
Author	22756 of 22756

**Source:* Own elaboration based on data entered into the Bibliometrix platform

In terms of the number of documents retrieved, we recovered a total of 7,140 papers, representing all documents available in the Web of Science database that correspond to our query. This substantial volume of papers confirms that the research topic enjoys constant, rigorous, and significant academic interest. Covering a period of approximately 50 years, the sample obtained allowed us to analyze the evolution of the subject over time and identify possible emerging trends.

We identified 2,497 unique sources, reflecting considerable diversity in publications addressing the researched topic, suggesting that the subject is not investigated exclusively in a narrow niche, but rather is explored from different perspectives, published in scientific journals of various profiles, and presented at relevant conferences, a diversity that provides us with a broad framework for analysis and the opportunity to examine the relevance of the topic in multiple related disciplines.

With regard to authors, the analysis revealed an impressive number of 22,756 authors who contributed to the retrieved papers. This high number suggests extensive international collaboration and broad interest in the topic investigated. At the same time, the high number of authors may indicate the existence of several independent research groups, each exploring different aspects of the influence of light source and photoperiods on broiler chickens.

We can affirm that the collected results indicate that the subject "Light Source" AND "Broiler Performance" is a field of research with intense and continuous scientific activity. The large number of papers, sources, and authors suggest high academic relevance and significant methodological diversity.

The authors' collaborative network

The next aspect analyzed is the authors' collaboration network, as it provides a relevant perspective on how researchers interact and collaborate within the field studied. The authors' collaboration network is represented by a graph in which each node corresponds to an author, and the lines between nodes indicate the existence of collaboration based on jointly published articles.

The size of the nodes reflects the authors' level of influence, determined by the number of direct collaborations, and the thickness of the lines signifies the intensity or frequency of these collaborations. In this network, distinct communities are represented by different colors, suggesting groups of researchers who collaborate frequently with each other.

With the help of the program, we created a collaboration network of authors, observing the existence of approximately 50 - 60 nodes, corresponding to different authors, and a large number of connections, especially within a predominantly blue cluster (Figure 1).

This network density suggests that we are dealing with an active group of researchers who collaborate frequently, resulting in a complex and well-connected network. We identified four major communities, each represented by a distinct color: *blue, purple, green, and red.*

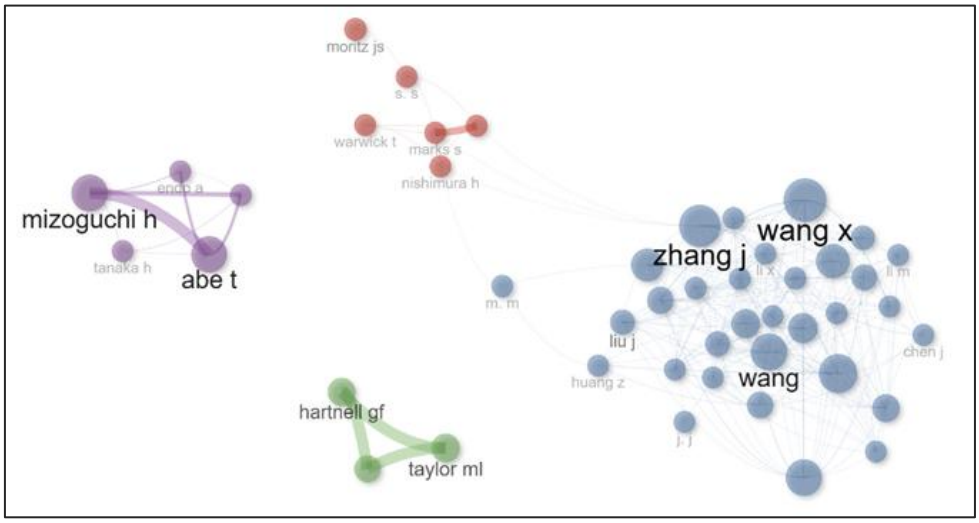

Figure 1. *Authors' collaboration network*
**Source: Developed by the Bibliometrix platform based on data entered by the author*

The blue cluster is the densest and most extensive, dominated by authors such as "Zhang J," "Wang X," and "Wang," who have a significant number of direct connections. This indicates that they are authors with major influence in the network, having the ability to connect various groups and significantly influence research directions.
In contrast, the purple group, formed around authors "Mizoguchi H" and "Abe T," is more compact and isolated, but shows strong connections between members, which may suggest collaboration focused on a specific theme.
We also observe the presence of two small groups, represented by green and red. The green group, centered around the authors "Hartnell Gf" and "Taylor Ml," is well connected internally but isolated from the rest of the network, indicating niche collaboration or a different research theme. The red group, being more dispersed, could represent authors with a low level of connectivity in the network, possibly involved in independent or marginalized collaborations.
In our analysis, we found that the blue group has the highest connectivity, suggesting an active interdisciplinary network in which authors collaborate frequently. At the same time, isolated communities, such as those in the purple, green, and red groups, could benefit from greater integration into the network by establishing connections with authors in the blue cluster.
Analysis of the authors' collaboration network allowed us to identify opinion leaders in the network, such as "Zhang J," "Wang X," and "Wang," as well as to observe distinct communities with varying levels of connectivity that may contribute to increased overall cohesion and better dissemination of knowledge.

Annual scientific production

The next aspect analyzed is annual scientific output, as it provides a comprehensive picture of the evolution of research over time, highlighting periods of growth, stability, or decline in the publication of scientific articles.
Analyzing these dynamics is essential to understanding how different research subfields have developed, how external events have influenced scientific activity, and to identifying emerging trends that can guide future research directions (Figure 2).

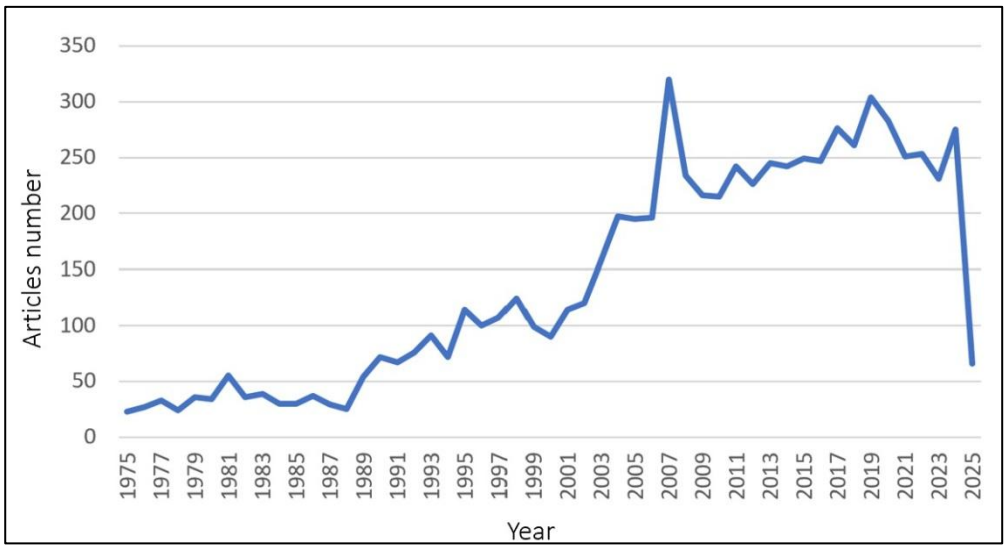

Figure 2. *Annual scientific production*
**Source: Developed by the Bibliometrix platform based on data entered by the author*

The graph shows the number of articles published each year over a long period starting in the 1970s and going up to the present day.
In the first decades, we observed a slow but steady increase in scientific output, reflecting both the expansion of access to research resources and the growing interest in certain emerging fields. At the same time, this period of gradual growth could also be explained by improvements in the infrastructure for publishing and communication between researchers.
Since the 1990s, we have seen rapid growth in the number of articles published annually, probably due to technological advances, the globalization of research, and increased access to databases and online resources. This growth continued until around 2010, when the graph reached a pronounced peak. It is possible that this peak is associated with a period of intensified scientific activity, either through an increase in the number of conferences, workshops, and journals available, or through more effective collaboration between researchers thanks to digital technologies.
After this peak, we observe a slight stabilization of scientific output, with moderate fluctuations until around 2020, which could be explained by reaching a natural limit of annual output, where the volume of published research is influenced by the scientific community's ability to generate new relevant knowledge at a constant rate.
Notably, at the end of the graph, there is a sharp decline in scientific output, which could be explained either by a lack of complete data for recent years or by a real reduction in

the volume of published research, possibly due to factors such as global crises (e.g., pandemics, economic crises), changes in funding policies, or fundamental changes in the structure of the research field.
Also, the transition to new publishing platforms or changes in authors' preferences regarding the dissemination of results could influence this decline.
Analyzing annual scientific output provides us with an understanding not only of the volume of research generated, but also of how it evolves over time, depending on various internal and external factors. Identifying periods of accelerated growth or stagnation contributes to the development of more effective strategies for stimulating collaboration, increasing the quality of publications, and adapting to new trends in the field.

Lotka's law

The next aspect analyzed is author productivity through the application of Lotka's Law, as it provides an effective method for understanding the distribution of authors' contributions in a given field of research. By identifying productivity patterns, we can assess the degree of involvement of authors and the relative importance of the most prolific among them.
Lotka's law, formulated by Alfred J. Lotka in 1926, states that the number of authors contributing n papers is inversely proportional to the square of that number. In other words, if a certain number of authors write a single article, then only a significantly smaller fraction will write two articles, an even smaller fraction will write three articles, and so on.
Mathematically, this is expressed as follows:

$$A_n = \frac{A_1}{n^2}$$

where:
A_n - is the number of authors who have published n papers;
A_1 - is the number of authors who have published a single paper;
n - indicates the number of works published by an author.

The application of Lotka's Law is relevant because it gives us a clear picture of the distribution of authors' contributions in the field studied. Most scientific fields are dominated by a small number of highly productive authors, while the majority of contributions come from authors who publish rarely or only a single paper. In this context, Lotka's Law helps us identify three important categories of authors and assess the overall distribution of productivity.
The first category consists of prolific authors, i.e., those who have published a significant number of works. They are usually opinion leaders or researchers with a major influence on the field. Their contributions are often recognized and frequently cited, thus influencing the direction of research and setting methodological or conceptual standards. The presence of these prolific authors is essential for the continuity and development of knowledge in a given field.
The second category consists of occasional authors, i.e., those who have published only one or two works. They represent the majority of the research community and, although

their contributions are rarer, they can offer unique or innovative perspectives. Their involvement in research, even sporadic, contributes to the diversity of the field and the development of new ideas.

The third category refers to the overall distribution of productivity, which allows for an assessment of the academic relevance of the field. It is important to determine whether there is an excessive concentration of scientific output among a small number of prolific authors or whether the field is characterized by a more balanced participation. A healthy field should have a balance between prolific and occasional authors, suggesting a diversity of contributions and a greater capacity for innovation.

The graph below illustrates the distribution of authors' productivity according to Lotka's Law. The horizontal axis shows the number of papers published by an author, and the vertical axis shows the percentage of authors who have produced a certain number of papers. We observe that a very large proportion of authors (over 60 %) have published only one or two works, which is consistent with Lotka's Law (Figure 3). As the number of published works increase, the percentage of authors decreases dramatically, following a negative exponential pattern, indicating that only a small number of authors are highly productive, while the majority contribute sporadically.

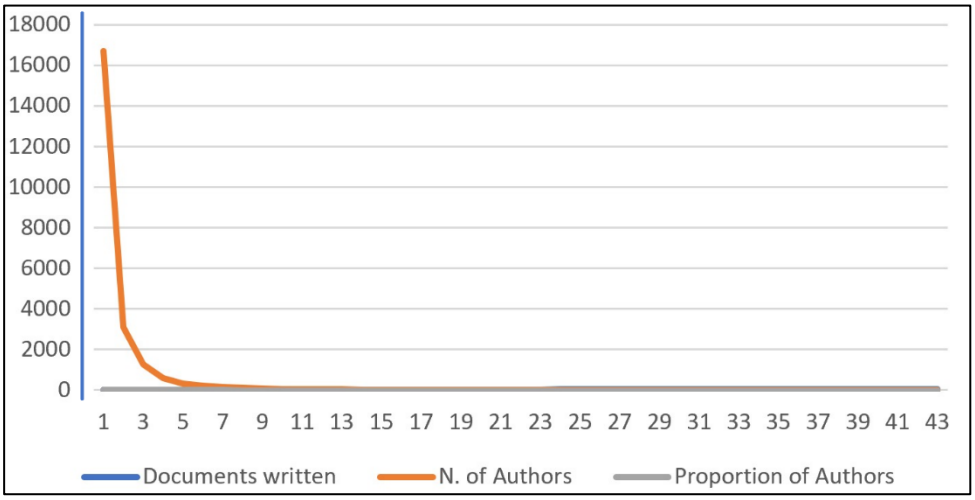

Figure 3. *Lotka's law graph*

**Source: Developed by the Bibliometrix platform based on data entered by the author*

Applying Lotka's Law helps us in several ways. First, by identifying leaders in the field, we can assess the impact of their research on the field and explore their potential collaborations with other researchers. It also allows us to estimate potential collaborations by identifying authors who publish less frequently. This enables us to develop strategies to encourage them to contribute more often or to collaborate with more prolific authors. In addition, it provides a tool for analyzing the balance of research, ensuring that the field is characterized by varied and diverse participation.

Keyword network

The last aspect analyzed is the keyword network, as it provides us with a clear overview of the main themes and concepts researched in the field analyzed. The network shown in the image illustrates the connections between relevant terms, allowing us to identify both

the central concepts and how they are related to each other, with the nodes in the network representing the main keywords and the connections between them reflecting co-occurrences or thematic relationships (Figure 4). At the same time, the different colors used for the nodes mark their belonging to different thematic groups, providing a clear segmentation of the research field.

Analyzing the network, we can observe three main themes. The first theme, represented by red, is related to broiler performance and includes terms such as "broiler", "performance", "diet", and "comparison". This group suggests a predominant interest in studies dedicated to evaluating broiler performance based on diet, comparison methodologies, and other relevant variables.

The second theme, represented by green, focuses on the influence and effects of factors on broiler performance, with terms such as "broiler performance", "effect", and "influence". This grouping indicates research that explores how various factors, such as diet, environment, or lighting, influence their performance.

The third theme, illustrated by blue, is associated with technical and development aspects, with terms such as "development", "light source", and "design". This theme is related to studies investigating the development of light sources and their design to improve broiler growth conditions, suggesting a technological orientation in research.

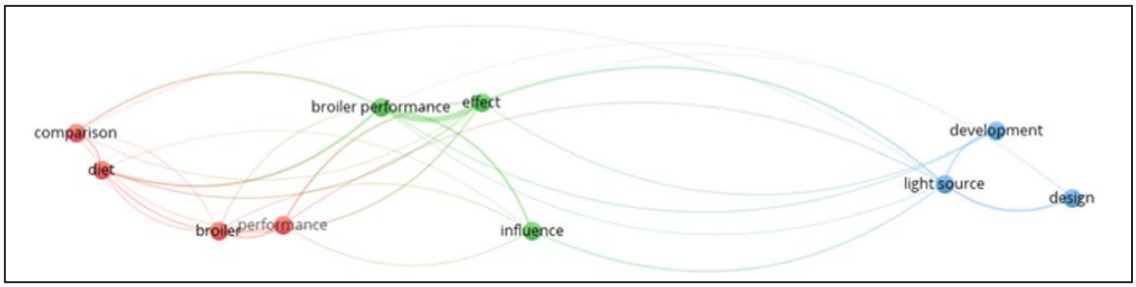

Figure 4. *Key terms network*

**Source: Developed by the Bibliometrix platform based on data entered by the author*

Analyzing the term map, we can see that there is interdependence between different themes. For example, the term "broiler performance" in the green group is connected to terms in the red group, indicating that broiler performance is a central concept that integrates various research approaches.

In addition, we note that the terms in the blue group, related to design and development, are connected to the other terms, suggesting that research on lighting and environmental design has direct relevance to studies on broiler performance.

Analyzing the keyword network provides us with valuable information about the thematic structure of the field and how key concepts are related to each other. Identifying these connections allows us to observe important subfields and emerging themes, as well as to assess the interdisciplinarity of research.

At the same time, this analysis can guide us in orienting future research by highlighting terms that are less connected or those that show potential for further investigation.

Practical implications for poultry production

The findings of this scientometric investigation delineate clear trajectories in research that bear direct implications for broiler production systems. Notably, the emergent emphasis on LED lighting technologies and precise photoperiod management underscores their multifactorial influence on growth performance, feed efficiency, and welfare outcomes in broiler flocks. Translating these insights into practice, poultry producers can optimize light intensity, spectral composition, and photoperiod schedules to synchronize physiological rhythms, thereby enhancing both productivity and the quality of meat products. Furthermore, the prominence of research clusters addressing meat quality suggests that strategic lighting interventions may modulate muscle development and carcass composition, offering tangible opportunities to align production practices with evolving consumer demands for high-quality poultry.
Beyond technical parameters, the analysis of co-authorship networks and influential scholars illuminates patterns of knowledge diffusion that are accelerating innovation in poultry lighting strategies. Engaging with these emerging research trends, either through collaborative trials or the adoption of evidence-based lighting protocols, allows industry stakeholders to integrate cutting-edge scientific findings into operational decision-making. By bridging the gap between scientometric insights and on-farm implementation, these strategies not only reinforce animal welfare and production efficiency but also establish a foundation for sustainable and technologically informed poultry management.

Limitations of the study

This scientometric analysis offers a comprehensive overview of research on lighting technologies and photoperiod effects on broiler performance and meat quality; however, several methodological considerations should be noted. The study relies exclusively on the Web of Science Core Collection, which, although extensive and well-curated, may omit relevant publications from other databases such as Scopus, Dimensions, or regional repositories. Additionally, the results are sensitive to keyword selection and Boolean search strategies, meaning minor variations could influence the identification of thematic clusters or emerging trends. While scientometric methods effectively reveal patterns in the published literature, they do not directly measure experimental outcomes or causal relationships, limiting the ability to draw definitive practical conclusions solely from publication trends. Moreover, the exclusion of non-English and non-indexed literature may underrepresent contributions from certain regions, potentially affecting the global generalizability of the findings. Despite these limitations, the study provides a valuable framework for understanding historical trends and emerging directions, offering guidance for future research and practical applications in poultry production systems.

CONCLUSIONS

The scientometric analysis reveals a sustained and growing scientific interest in the field, as reflected by the continuous increase in publication output since the 2000s and the diversification of research into interdisciplinary areas, including optics, photonics, and advanced poultry technologies.

Collaboration analysis showed a typical distribution, with a limited number of highly productive authors alongside a larger group of occasional contributors, highlighting the presence of both established experts and emerging collaborators.
Keyword network mapping identified three interconnected core themes - broiler performance, influencing factors, and technological development of light sources - demonstrating a coherent conceptual structure and substantial interdisciplinarity.
Overall, these results confirm the relevance of the study, providing a solid and comprehensive foundation for guiding future research directions in the field and supporting the integration of emerging technologies and approaches.

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