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A Bibliometric Analysis of Publications During The Last Decade on Growth Performance In Animal Science

Hayvan Bilimlerinde Büyüme Performansı Üzerine Son On Yılda Yapılan Yayınların Bibliyometrik Analizi

Fatma YARDİBİ [1] 0000-0001-8852-2708
Mehmet Ziya FIRAT[1] 0000-0002-0091-4713

[1] Department of Animal Science, Akdeniz University, Antalya, Turkey

Corresponding author: fatmayardibi@gmail.com

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Bibliometric analysis, CiteSpace, growth performance, nutrient digestion, trend topic

ABSTRACT

Objective: The studies conducted in growth performance are significantly related to productivity; consequently, this field a critical part of animal science. Zootechnical research in this field is growing, and bibliometric analysis of publications may guide the researchers and raise awareness on specific research trends and key topics.

Material and Methods: This paper reviewed the growth performance literature via multiple analyses to examine the growth and global longitudinal trends through bibliometric analysis and network analysis. The research data consisted of 10240 studies published between 2010-2020 by the selected criteria. A visualization tool called CiteSpace, which reveals a deep level analysis, especially for future research trends prediction, was used.

Results: It was concluded that 2010 was a turning point in this field, as it was observed that academic studies were mostly carried out in 2010, and these studies were more cited. The most cited reference is the National Research Council studies; the most active country in the academic publication is China (2236 counted.) Accepted as a turning point or central point, the country with the highest centrality value was the USA (0.20). It has been seen that the main researches focused on nutrient digestion, broiler chicken, and meat quality.

Conclusion: In this study, our combination of bibliometric methods and a systematic review makes for a better understanding of growth performance methods for both researchers and practitioners. Thus, this paper concentrates on filling the gap in Zootechnical researches by carrying out a visualized bibliometric analysis to discover the existing themes, hot topics, and potential future research directions.

Anahtar Kelimeler:
Bibliyometrik analiz, CiteSpace, büyüme performansı, besin sindirimi, güncel konular

ÖZ

Amaç: Büyüme performansı konusunda yapılan çalışmalar önemli ölçüde verimlilik ile ilgilidir; sonuç olarak, büyüme performansı zootekninin önemli bir parçasıdır. Zootekninin bu alanında yapılan çalışmalar giderek artmaktadır. Yayınların bibliyometrik analizi araştırmacılara belirli araştırma eğilimleri ve kilit konular hakkında rehberlik edebilir ve farkındalık yaratabilir.

Materyal ve Metot: Bu makalede, büyüme performansı literatür alanın gelişimini, küresel boylamsal eğilimlerini incelemek için bibliyometrik analiz ve ağ analizileri çoklu analizler yoluyla incelenmiştir. Araştırma verileri, seçilen kriterlere göre 2010-2020 yılları arasında yayınlanan 10240 çalışmadan oluşmaktadır. Özellikle gelecekteki araştırma eğilim tahminine yönelik derin bir analiz ortaya koyan CiteSpace adlı bir görselleştirme aracı kullanıldı.

Bulgular: Akademik çalışmaların daha çok 2010 yılında yapıldığı ve bu çalışmaların yüksek sayıda atıf alması nedeniyle 2010 yılının bu alanda bir dönüm noktası olduğu sonucuna varılmıştır. En çok alıntı yapılan referans Ulusal Araştırma Konseyi çalışmalarıdır; akademik yayında en aktif ülke Çin Halk Cumhuriyeti'dir (2236 akademik çalışma). Bir dönüm noktası ya da merkezi nokta olarak kabul edilen merkeziyet değeri en yüksek olan ülke ABD (0.20) oldu. Başlıca araştırmaların besin sindirimi, etlik piliç ve et kalitesine odaklandığı görülmüştür. ***Sonuç:*** Bibliyometrik yöntemler ve sistematik incelemeden oluşan bu çalışma hem araştırmacılar hem de uygulayıcılar için büyüme performansı yöntemlerinin daha iyi anlaşılmasını sağlar. Bu nedenle, bu makalede, mevcut konular ve gelecekteki potansiyel araştırma yönlerini keşfetmek için görselleştirilmiş bir bibliyometrik analiz yapılmıştır. Dolayısıyla, Zootekni alanında yapılan araştırmalardaki boşluğu doldurmaya odaklanmaktadır.

1. INTRODUCTION

The current world population of about 7.6 billion, and it is anticipated to reach 8.6 billion in 2030, 9.8 billion in 2050, and 11.2 billion in 2100 (United Nations Report, 2017). In parallel with the increase in the world population, the need for agriculture and livestock products is increasing. Unfortunately, due to the limitation of arable lands and animal production areas, improving production efficiency is the only way to meet the requirements in the future. Therefore, growth performance in animal production has become a critical research field. Several countries and institutions support the studies in this field to meet the increasing demand with high productivity and economical value.

Bibliometrics can be used to identify patterns associated with publications in a particular field, and citation data can be evaluated quantitatively to understand significant research areas and predict future research directions (Wang et al., 2020). Therefore, it helps researchers get an overview of the main studies and the topics that guide the field. Furthermore, it allows researchers to identify the status and trends of a specific field and make academic decisions (Ellegaard and Wallin, 2015). Bibliometrics is the quantitative analysis of research publications using mathematical and statistical methods (Pritchard, 1969). The use of bibliometric indicators has increased in recent years. Bibliometric information saves much time for researchers before start field research and provides information about the main trends observed in the fields studied and about the direction and quality of scientific research as they show the structural content of reviews in the field (Iqbal et al., 2019; Abejon et al., 2017). One of the main components of bibliometric studies is co-citation analysis. Researchers use the co-citation analysis to recognize if any new theory stems from existing literature. It can be used to display the scientific communication structure between researchers and the distribution of information. Thus, it provides a historical view of the knowledge structure of a particular field. (Cui et al., 2018). CiteSpace is one of the most popular software tools used to analyze co-citation networks. Visualization information maps used for bibliometric analysis in CiteSpace consist of nodes and links. Nodes represent the analytic items (i.e., author, journal, reference) of CiteSpace. The node size displays the aggregate co-occurrence frequency of an item, whereas the node's thickness and the ring's color show the co-occurrence time slices of this item (Chen et al., 2012). Further, the relationship between different nodes is showed as a colored line, which is called links. Links between nodes define relationships of collaboration/co-occurrence or co-citations, and the different colors of nodes and lines represent years. The thickness of a line between different nodes displays the frequency of co-citation. The lines' color indicates the first year of co-citation relationships among these nodes (Chen et al., 2012). Structural measures such as mean silhouette score, modularity Q index, and betweenness centrality value are used to evaluate the network's structural quality. The betweenness centrality, which measures a node's ability to connect with other nodes, is another crucial index (Chen et al., 2010). The high centrality of nodes is usually regarded as turning points or central points in a field (Chen, 2006). The higher the frequency, the greater the influence, and the centrality value exceeding 0.1 have more impact (Su et al., 2019). The average silhouette score measures the cluster's quality and cluster's homogeneity, with high scores displaying the clustering's high quality (Chen, 2006). Another metric is citation burst, which is considered to be a hot point in a field of research. A burst term is defined as a keyword or author, or institution that appears with an abrupt change in frequency within the literature during a specific period (Li et al., 2020). Furthermore, the timeline view finally provides an overview of the evolution of clusters in the field over time and shows whether these developments continue over the years (Li, 2020).

This bibliometric analysis aims to evaluate the importance and impact of the academic studies that have been published on the topic of growth performance during the period 2010-2020. It also reveals that this field has received increased attention and interest from researchers, research funding institutions, and practitioners. In this way, it is thought that it will guide researchers and pave the way for new studies.

2. MATERIAL and METHODS

2.1. Methods

A bibliometric analysis was applied to growth performance's topic to investigate the birth, origin, development, and evolution of a field and the current status and possible trend. For this purpose, CiteSpace 5.7.R 2 (update 28.09.2020, software available http://cluster.cis.drexel.edu) is used. This method was preferred because of its various advantages. First, it shows the network map of cited references, authors, institutions, and countries, making it easy to trace the original theoretical roots and history. Second, the analysis of selected keywords shows the evolution over time. It can help researchers to trace the shift in research and identify opportunities to extend the research fields. Finally, our results in identifying theories and frameworks allow us to identify journals,

institutions, and references contributing to our understanding of animal science research. The network visualizations were analyzed with nodes, links, and some critical indexes. Nodes were analyzed according to the analytic items (reference, author, journal, keyword, etc.) of CiteSpace. Structural metrics involving the average silhouette score, the modularity Q index, and the betweenness centrality to assess the networks' structural quality was used. Using the multidimensional methods via CiteSpaces described the properties and connections of the network, and we generated clusters with a timeline view of the structures. This timeline view provided an overview of the evolution of clusters in the field over time and showed the change of the field over the years.

2.2. Data collection

To identify relevant search terms were analyzed five journals that have the highest impact factor according to the Incites Journal Citation Reports (https://jcr.incites.thomsonreuters.com) in The Agriculture, Dairy, and Animal Sciences category. Then, as a result of the study's bibliometric analysis, we determined "growth performance" as the current one of the most effective area, and we chose the area we determined as a keyword. Web of Science is one of the most well-known and influential actual academic database websites (Seyedghorban et al., 2016). It is suggested as the preferred database website for CiteSpace analysis (Chen, 2006). We first chose the Web of Science Core Collection rather than all Databases to obtain full records (title, author, publication information, abstract, reference) of influential papers and eliminate the subordinate papers. Web of Science Core Collection (update: 14.12.2020) data, which consists of 25500 publications in total, had been downloaded. Search criteria were selected Searching term (Topic): "growth performance," Time-span (Years): 2010-2020, Categories: Agriculture Dairy Animal Science, Document types: article and review, Language: English. According to the determined criteria, 10240 study data were reached and recorded in an appropriate format. The recorded data was converted to excel data, and it was checked whether there was duplication. Later, it was converted into a suitable data file format for CiteSpace, recorded, and analyzed.

3. RESULT

A total of 10240 academic outputs met inclusion criteria and were included in bibliometric analysis. The steady increase in the number of articles published from 2010 to 2020 illustrates that growth performance has still been an active topic in recent years. Figure 1 displayed the distribution of the publications by years.

The annual publication output showed growth between 2010 and 2020, with 10240 publications. As a result of the analysis of 65 highlighted cited publications, the sum of the cited 4180 times, average citations 64.31 per item, and h-index 37 were found. The number one highlighted publication, "Adaptation to hot climate and strategies to alleviate heat stress in livestock production," has cited an average of 34.78 per year (Renaudeau et al.,2012). Usually, papers attain their citation peak after publication two, three, or even four years. These papers are frequently key papers in their fields. "hot" papers are recently published papers and unusual citation activity in a current time period. "The Potential Role of Insects as Feed: A Multi-Perspective Review," written by Sogari and et al. (2019), was a hot paper in this field.

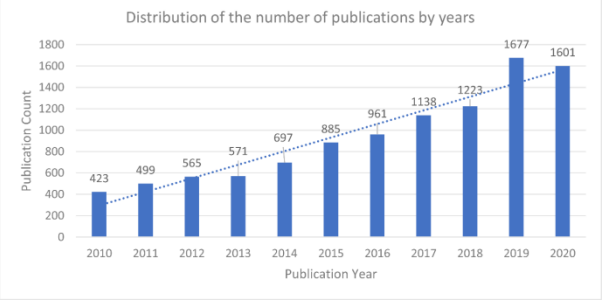

Figure 1. Number of publications for each year from 2010 to 2020 in the Web of Science

Şekil 1. *2010 Yılından 2020 Yılına Kadar Web of Science'de Yayınlanan Yayın Sayısı Dağılımı*

3.1. Analysis of references

The co-citation network of a total of 172.304 cited references related to 10.240 publications consisted of 1093 nodes and 4683 links, and network density in the illustration (Figure 2A) is calculated as 0.008. Since the density value is close to 0, we can say that the connection density is low. The thickness of a ring around the node can be compared to the number of citations received during this time period. Therefore, a large circle indicates a highly cited unit specified as a reference. A line between two rings reflected the co-citation link of two cited references, with its thickness showing the strength of co-citation and its color showing the time of the first co-occurrence. The "Nutrient Requirements of Swine" research by the National Research Council in 1998 (10th. Revised Edition) and 2012 (Eleventh Revised Edition) is one of the most referenced studies in this field.

The modularity Q and silhouette-values were calculated for cluster analysis. According to the reference analysis result, the Modularity Q value was 0.7298, and the Mean Silhouette value was 0.8929. It means that the network is reasonably divided into

clusters and suggests that the homogeneity of these clusters was very high. A total of 10240 academic works were divided into 16 clusters and displayed in Figure 2B. Colors, changing from white to red, indicate the citation time from 2010 to 2020, respectively. Each cluster block (# 0–16) is separated by different colors (Figure 2B). Each cluster block's color designates the year of the co-citation relationship that occurred first in each cluster. For instance, publications in the white block were published earlier than those in the green block. Cluster analysis helps us to understand the main features of science mapping (Chen, 2016). A summary of the cluster details was given in Table 1.

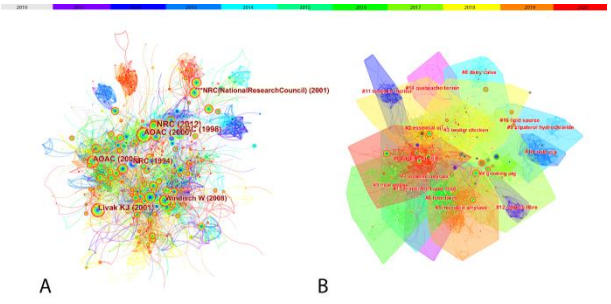

Figure 2. Maps of references cited in the literature from 2010 to 2020 on growth performance (A) Co-citation network map of references. The nodes on the map represent different references. (B) Cluster map of references. The name of the cluster represents the topics of the references

Şekil 2. *Büyüme performansı literatürünün 2010'dan 2020'ye kadar referans haritaları. (A) Ortak atıf ağı referans haritası. Haritadaki düğümler farklı referansları temsil eder. (B) Referansların küme haritası. Kümenin adı, referansların konularını temsil eder*

Table 1. Cluster Summarize
Çizelge 1. *Küme Özeti*

Cluster ID	Size	Silhouette	Year
#0 (bacillus subtilis)	156	0.828	2006
#1 (microbial phytase)	140	0.890	2004
#2 (essential oil)	122	0.891	2008
#3 (broiler chicken)	115	0.842	2005
#4 (growing pig)	105	0.856	2005
#5 (heat stress)	97	0.934	2008
#6 (feed from)	60	0.954	2007
#7 (sodium butyrate)	58	0.853	2010
#8 (dairy calve)	36	0.951	2008
#9 (zilpaterol hydrochloride)	32	0.971	2004
#10 (male pig)	30	0.987	2006
#11 (tenebrio molitor)	30	0.973	2015
#12 (soluble fibre)	20	0.987	2001
#13 (fermented liquid feed)	19	0.970	2008
#14 (quebracho tannin)	17	0.975	2008
#16 (liqid source)	6	0.998	2011

Table 1 shows that the cluster size, silhouette values, and mean (years) of the 16 largest clusters were automatically selected according to the reference. (The table consists of the Cluster ID column with each cluster named to correspond to an underlying theme, a topic, or a research area, the Size column showing the size of the cluster, the Silhouette column showing the homogeneity of a cluster, and the Year column showing the average year of publication of a cluster.)

Table 2. Top 10 References with the Strongest Citation Bursts
Çizelge 2. *Referansa Göre En Güçlü 10 Atıf Patlaması*

References	Year	Strength	Begin	End	2010 - 2020
NRC, 1994, NUTR REQ POULTR, V0, P0	1994	148.11	2010	2014	
NRC, 1998, NUTR REQ SWIN, V0, P0	1998	106.21	2010	2014	
VANSOEST PJ, 1991, J DAIRY SCI, V74, P3583	1991	68.56	2010	2011	
AOAC, 1995, OFFICIAL METHODS ANA, V0, P0	1995	39.34	2012	2015	
AOAC, 2000, OFF METH AN, V0, P0	2000	35.87	2010	2012	
AOAC, 1995, OFF METH AN, V0, P0	1995	34.24	2010	2012	
NRC, 1996, NUTR REQ BEEF CATTL, V0, P0	1996	17.93	2010	2016	
Short FJ, 1996, ANIM FEED SCI TECH, V59, P215	1996	17.38	2013	2016	
Dunshea FR, 2001, J ANIM SCI, V79, P2524	2001	16.28	2011	2014	
Caporaso JG, 2010, NAT METHODS, V7, P335	2010	16.22	2018	2020	

Table 2 shows the top 10 references with the highest citation bursts and their years of popularity. Bars in red color indicate the active citation burst duration between 2010 and 2020, whereas the blue-colored thinner bar corresponds to the inactive duration. (The table consists of the reference column where the referenced source is given, the Year column showing the publication year of the referenced source, the Strength column showing the strength of the citation burst, the Begin and End columns showing the start and end years of the citation burst, and the 2010-2020 column showing the duration of the citation burst in bars.)

Clusters were numbered from 0 to 16, Cluster #0 (bacillus subtilis) was the largest cluster, and Cluster #1 (microbial phytase) was the second-largest one. One of the other most massive clusters is Cluster # 2 (essential oil). Table 2 showed the citation burst analysis results to see the most popular years of studies conducted by different researchers.

The first ten citation bursts out of 324 citation bursts are shown in Table 2. In the last column, the

start and end times of the citation burst are given. As can be seen from the table, the citation bursts by reference are mostly started in 2010. The strongest citation burst was found in the National Research Council's research on Nutrient Requirements of Poultry in 1994. The second strongest citation burst was found in the National Research Council's research on Nutrient Requirements of Swine in 1998, and at the same time, this study was the most cited reference (Figure2A). CiteSpace provides different display modes, cluster views, and timeline views. The timeline view highlights the co-citation network changes with time, and Figure 3 shows a timeline visualization of the 15 largest clusters and their interrelationships.

The largest top four clusters were active from 2000 to 2018, but they are not as efficiently active currently (Figure 3). Cluster #5 "heat stress" is still an active cluster. Timeline visualization was showed that the references were mostly given to studies conducted between 2000 and 2010. It can be said that the area developed in these years reached its mature structure at present.

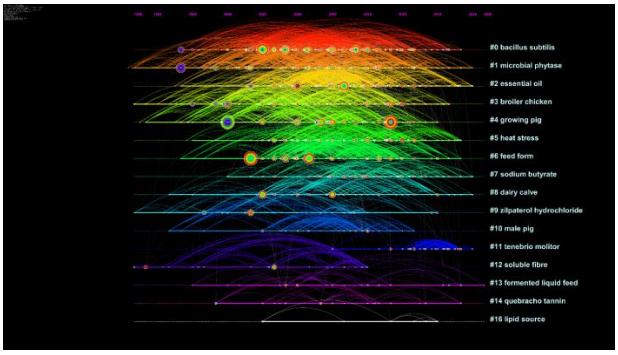

Figure 3. According to references cluster map in the timeline. The chronological order in which the references appear in each cluster is found
Şekil 3. *Referanslara göre küme analizi haritasının zaman çizelgesi. Her kümede referansların ortaya çıkışı kronolojik sırada yer alır.*

3.2. Analysis of the author

A total of 23229 authors published manuscripts related to growth performance topics during the last decade. The most active author in the growth performance field was Kim IH (h-index:33), shown as the big node in Figure 4A. The network consists of 723 nodes and 2280 links. Also, the density of the network was calculated as 0.0087. The authors' co-authorship map and cluster map were shown in Figure 4A and Figure 4B, where each node represents an author.

In total, 115 clusters were generated, with a Q-value of 0.7512 and silhouette-values of 0.9209. It means that the network was divided into homogeneous reliability clusters. The cluster summary was given in Table 3.

If the cluster silhouette value is low, it is not shown in the cluster summarize table or timeline visualized by the software due to cluster heterogeneity (Chen et al., 2010). The silhouette value of all clusters was greater than 0.7; the clusters were well clustered in a homogeneous structure. It was seen that the most preferred subject of the authors is "nutrient digestion," which is the biggest cluster. The results of burst analysis, which have been performed to see the most popular years of the works performed by different researchers, were shown in Table 4.

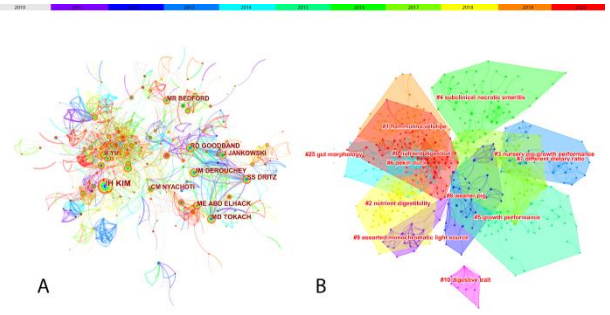

Figure 4. Maps of the author relationship from 2010 to 2020 (A) Co-citation network map of the author. The nodes in the map represent cited authors. (B) The cluster of authors. The name of the cluster means the topics of cited authors. Lines between the nodes represent co-citation relationships/
Şekil 4. *2010 dan 2020 ye kadar yazar ilişkileri haritası. (A) Yazarın ortak atıf ağı haritası. Haritadaki düğümler, alıntı yapılan yazarları temsil eder. (B) Yazarlar için konu küme haritası. Kümenin adı, alıntı yapılan yazarların konularını ifade eder. Düğümler arasındaki çizgiler ortak alıntı ilişkilerini temsil eder*

Table 3. Cluster of author summarizes /
Çizelge 3. *Yazar Küme Özetleri*

Cluster ID	Size	Silhouette	Year
#0 (nutrient digestion)	80	0.843	2016
#1 (flammulina velutipe)	64	0.912	2015
#2 (nutrient digestibility)	58	0.906	2014
#3 (nursery pig growth performance)	54	0.957	2012
#4 (subclinical necrotic enteritis)	54	0.958	2014
#5 (growth performance)	52	0.948	2016
#6 (pekin duck)	49	0.874	2016
#7 (different dietary ratio)	36	0.949	2014
#8 (weaner pig)	35	0.952	2012
#9 (assorted monochromatic light source)	18	0.994	2014
#10 (digestive trait)	11	0.999	2012
#25 (gut morphology)	4	0.998	2015

Table 3 shows the cluster size, silhouette values, and mean (years) of the 12 largest clusters automatically selected

L Yan and QW Meng, among the ten strongest citation bursts, collaborated with the most active author Kim IH. The "Influence of probiotics in different energy and nutrient density diets on growth performance, nutrient digestibility, meat quality, and blood characteristics in growing-finishing pigs" article by these authors and their colleagues in 2010 has a high impact on the field. A total of three citation bursts, including the first citation burst, belong to cluster #2 (nutrient digestibility). Among the most active authors, RD Goodband, MD Tokach, SS Dritz, JM Derouchey collaborated with JL Nelssen, who has the second strongest citation burst. These authors' collaborative work, "Effects of dried distillers grains with solubles on carcass fat quality of finishing pigs," was highly cited (Benz et al., 2010), and their researches belonged to cluster #3 (nursery pig growth performance). The timeline visualization of the network, as illustrated in Figure 5, provided an overview of the development of research fields.

***Table 4**. Top 10 Authors with the Strongest Citation Bursts*
***Çizelge 4.** En Güçlü 10 Yazar Atıf Patlaması*

Authors	Year	Strength	Begin	End	2010 - 2020
L YAN	2010	16.67	2010	2013	
JL NELSSEN	2010	13.88	2010	2014	
QW MENG	2010	10.22	2010	2011	
GG MATEOS	2010	10.20	2010	2016	
JV O'DOHERTY	2010	9.18	2010	2012	
SL INGALE	2010	9.01	2011	2014	
SI LEE	2010	8.54	2016	2018	
V TUFARELLI	2010	8.06	2011	2015	
ZF ZHANG	2010	8.00	2013	2014	
RT ZIJLSTRA	2010	7.98	2010	2016	

Table 4 shows the top 10 authors with the highest citation bursts and their years of popularity. Red line indicates the active citation burst duration between 2010 and 2020, whereas the blue line corresponds to the inactive duration.

The figure showed that "nutrient digestion" was the most active area in this field and was recently trending. Moreover, this cluster was the longest. As can be seen from the timeline view also showed that "flammulina velutipe," "subclinical necrotic enteritis," and "growth performance" were active clusters. The lack of animal protein for human consumption can be attributed to the decline in animal protein production, especially in developing countries, to the high cost of livestock production, mainly to feed costs, which can be up to 70% of the total production cost. Therefore, any reduction in feed cost will significantly reduce overall production costs (Safwat and et al. I, 2015). Since the high cost of protein source feedstuffs and environmental concerns in animal production, nutritionists are encouraged to use exogenous enzymes in poultry diets. Exogenous enzymes are regarded as "pro-nutrient" in poultry diets and reported that these enzymes improve nutrient digestibility and poultry's growth performance (Law and et al., 2015). Therefore, it is understandable that nutrient digestion is a hot topic.

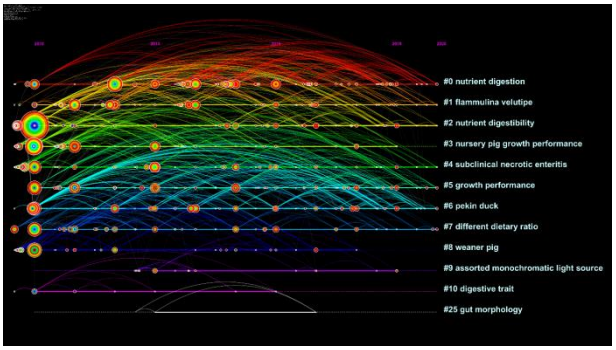

Figure 5. According to the authors' cluster map in the timeline visualization. The chronological order in which the authors appear in each cluster is located/
***Şekil 5.** Yazarların küme haritasına göre zaman çizelgesi görselleştirmesi. Yazarların her kümede göründüğü kronolojik sıraya göre gösterilir.*

3.3. Analysis of the institution

The network consists of 509 nodes in which each node represents an institution and 2452 links of nodes. The density of the network was calculated as 0.019. Dankook University (counted 358) was the most active institution and belonged to cluster #6 (dietary protease). The institutions' network map and cluster map are shown in Figure 6A and 6B, respectively.

Clusters were obtained, with a Q-value of 0.4938, a silhouette value of 0.9209. The relatively low Q value indicates that the clusters were intertwined. However, the silhouette value showed that the network cluster was homogeneous and reliable. The largest nine of the 58 clusters in total were given in Table 5.

All clusters are larger than 0.7, and it can be said that it has sufficiently homogeneous and useful clustering. Citation bursts are used to recognize abrupt changes in events and are given in Table 6.

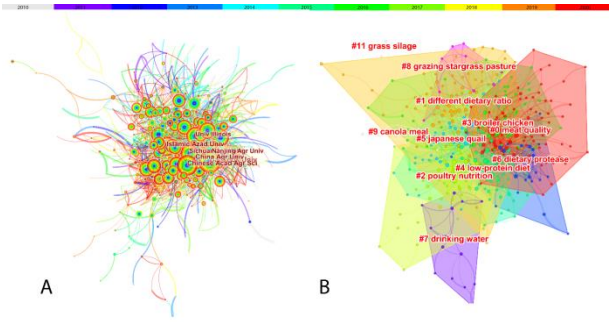

***Figure 6**. Maps of the institution relationship from 2010 to 2020 (A) Co-citation network map of the institution. The nodes in the map represent the cited institutions. (B) The cluster of institutions. The name of the cluster means the topics of cited institutions. Lines between the nodes represent co-citation relationships/*
***Şekil 6.** 2010 dan 2020 ye kadar kurum ilişkileri haritası. (A) Kurumun ortak atıf ağı haritası. Haritadaki düğümler, belirtilen kurumları temsil eder. (B) Kurumlar kümesi. Kümenin adı, atıfta bulunulan kurumların konularını ifade eder. Düğümler arasındaki çizgiler ortak alıntı ilişkilerini temsil eder.*

Table 5. Institution cluster summarize
***Çizelge 5.** Kurum Küme Özeti*

Cluster ID	Size	Silhouette	Year
#0 (meat quality)	89	0.811	2014
#1 (different dietary ratio)	84	0.808	2014
#2 (poultry nutrition)	62	0.829	2014
#3 (broiler chicken)	59	0.773	2013
#4 (low-protein diet)	57	0.810	2014
#5 (japanese quail)	41	0.803	2014
#6 (dietary protease)	28	0.845	2014
#7 (driking water)	14	0.983	2014
#8 (grazing stargrass pasture)	10	0.956	2011
#9 (canola meal)	7	0.991	2015
#11 (grass silage)	4	0.992	2018

Table 5 shows the cluster size, silhouette values, and mean (years) of the 11 largest clusters automatically selected.

The top ten out of 128 citation bursts in total were given in the table. North Carolina State University was the strongest citation burst in 2010 and belonged to cluster #0 (meat quality). INRA (Institut national de la recherche Agronomique) and University Politecn Madrid belong to cluster #1 (different dietary ratio). The timeline view showing the changing clusters overtime was given in Figure 7. Cluster #1 (different dietary ratio), with the longest time, was still an active topic, and institutions still prefer studying this area. The largest size cluster, "meat quality" is not a direct active study area today, and it is being studied with other fields. Thereby, this cluster has shifted to other clusters. "poultry nutrition," "broiler chicken," and "dietary protease" were still preferred topics.

Table 6. Top 10 Institutions with the Strongest Citation Bursts /
***Çizelge 6.** En çok atıf patlaması yapan 10 kurum*

Institutions	Year	Strength	Begin	End	2010 - 2020
North Carolina State University	2010	20.76	2010	2015	
INRA	2010	17.73	2010	2015	
University Alexandria	2010	10.26	2011	2015	
Alberta Agr & Rural Dev	2010	9.10	2010	2014	
University Politecn Madrid	2010	9.04	2010	2014	
University Missouri	2010	8.63	2010	2014	
University Nebraska	2010	8.31	2012	2015	
Swedish University Agr Sci	2010	8.21	2010	2013	
Louisiana State University	2010	8.00	2010	2011	
University Ghent	2010	7.35	2010	2016	

Table 6 shows the top 10 institutions with the highest citation bursts and their years of popularity. Red line indicates the active citation burst duration between 2010 and 2020, whereas the blue line corresponds to the inactive duration.

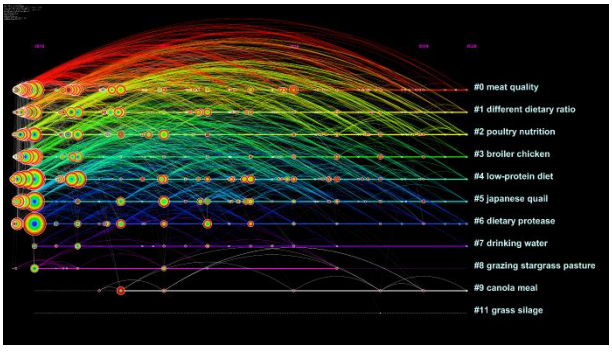

Figure 7. According to the institution cluster map in the timeline visualization. The chronological order in which the institutions appear in each cluster is located/
***Şekil 7.** Kurumların küme haritasına göre zaman çizelgesi görselleştirmesi.*

3.4. Analysis of the countries

The network consists of 123 nodes in which each node represents countries and 918 links of nodes. The density of the network was calculated as 0.1224. Table 7 displayed the most active countries.

China was a higher frequency (2236), and the centrality value of 0.09, measured by the number of links passing through a node, expresses the importance of a node and has an effect. On the other

hand, the USA is the country with the second-highest frequency (1867) and the highest centrality value with 0.20. With a high centrality score, the USA was not only closely related to different groups of nodes but was located in between other countries. The other countries with high betweenness centrality values are Italy (0.18), Spain (0.17), England (0.17), South Africa (0.13), Germany (0.12), and Iran (0.11). Modularity Q reached 0.2494 < 0.3, and the structure is not reasonable enough; it means that clusters are partially nested and not fully separated. The silhouette score reached 0.7462 > 0.4, and the result is valid. Figure 8A showed the Countries Network structures of visualization. Figure 8B showed the cluster structures.

Table 7. The most active countries with its centrality value
Çizelge 7. *Merkeziyet Değeriyle En Aktif Ülkeler*

Counted	Centrality	Year	Countries
2236	0.09	2010	People's Republic of China
1867	0.20	2010	USA
877	0.11	2010	Iran
788	0.02	2010	South Korea
564	0.06	2010	Canada
542	0.02	2010	Brazil
504	0.08	2010	Egypt
483	0.02	2010	India
436	0.04	2010	Poland
412	0.18	2010	Italy

(Table 7 consists of the Counted column showing the total number of publications made by the countries, the Centrality column showing the betweenness centrality value of the node, the Year column showing the first publishing time within the selected time interval, and Countries column with the country names.)

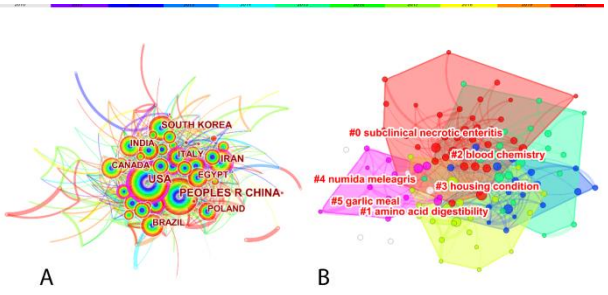

Figure 8. Maps of the country relationship from 2010 to 2020 (A) Co-citation network map of countries. The nodes in the map represent the cited countries. (B) The cluster of countries. The name of the cluster means the topics of cited countries. Lines between the nodes represent co-citation relationships/
Şekil 8. *2010'dan 2020'ye ülke ilişkilerinin haritaları (A) Ülkelerin ortak atıf ağı haritası. Haritadaki düğümler, belirtilen ülkeleri temsil eder. (B) Ülkeler kümesi. Kümenin adı, adı geçen ülkelerin konularını ifade eder. Düğümler arasındaki çizgiler ortak alıntı ilişkilerini temsil eder*

The thickness of the links shows that cooperation between countries was strong. Cluster # 2 (blood chemistry) has a relatively smaller silhouette value. It has a heterogeneous structure compared to other clusters. Ireland has the highest stronger citation burst and longest burst duration. The timeline for clusters on the countries basis is given in Figure 9.

It is seen that in 2010, intensive studies were carried out and the field matured over time. It was shown that the most active clusters were subclinical necrotic enteritis, amino acid digestibility, blood chemistry, and housing condition was preferred active topics based on countries.

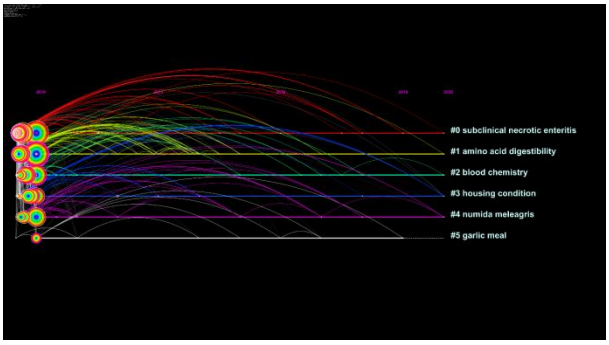

Figure 9. According to the country cluster map in the timeline visualization. The chronological order in which the country appear in each cluster is located/
Şekil 9. *Ülkelerin küme haritasına göre zaman çizelgesi görselleştirmesi.*

4. DISCUSSION AND CONCLUSIONS

Inspired by the idea that a variety of research fronts may arise from a common intellectual base, we have examined the historical development of the intellectual bases of growth performance. This bibliometric study aimed to analyze the current status and trends during the past decade, between 2010 and 2020, of publications on growth performance using CiteSpace. As a result of the analysis, it was seen that intensive academic studies were conducted in 2010 due to the density and size of the nodes in the timeline visualization. In addition, more citations were made to the studies conducted in this period. Therefore, it was concluded that key studies in the field were carried out in the 2010s and these studies played an essential role in the development of the field. It was determined that the most cited source was the research conducted by the National Research Council in different years. Hence, it can be said that the National Research Council's publications are key sources in growth performance. In other words, it has been a pioneer in the development of the field. It was concluded that the authors mostly preferred to work on "nutrient digestion or digestibility," "flammulina velutipe," and "subclinical necrotic enteritis," which are still a trending subject. "Broiler chicken" and "poultry nutrition," and "low-protein diet," which are the most active subjects that institutions prefer to work on, are the study areas to be recommended for new researchers. As a result of the general review of growth performance common literature, its subfields broiler chicken, nutrient digestion or digestibility, meat quality are hot topics. Along with "growth

performance," it has been observed that the most used keywords are "broiler," "digestibility," and "supplementation." The most active country was the Peoples' Republic of China. The USA had the highest centrality value; thus, the more significant its role in the communication between other nodes. Ireland is an influential country in the field with the most potent citation burst. Review articles also increased in more recent years, reflective of the maturing nature of the field. The most cited journals were the Journal of Animal Science, Poultry Science, and Animal Feed Science Tech. The top ten highlights cited publications' topics were consistent with the cluster analysis results performed for different types of nodes. Cost is as important as the nutritional content in the diet of farm animals, which is one of the factors that directly affect growth performance. It is ideal to obtain a richly ingredients and digestible feed at a lower cost. The result of the study has also shown that studies in these areas are trending topics. The evidence presented in this review contributes to discussions about how this field has grown, developed, and is changing over time and its influence.

One limitation of this work is that it has been selected on publications whose article language is English to reflect a global structure. The reviews of countries, especially China, which has the most impact, can be analyzed separately. Animal Science studies differ based on countries due to geographic, structural differences. Academic studies in each country can be country-specific. Nonetheless, the literature summary of the studies in growth performance with this study is still guiding in understanding the general structure and following the up to date.

As a result, with this study, one of the most significant advantages of bibliometric analysis was used by analyzing big data where cooperation and citation relationships were complicated. Moreover, it is thought that this will help researchers save time by creating the general framework of the literature for more efficient work by identifying the right collaborations and topics. In some ways, this article can be regarded as demonstrating to study a new field briefly and quickly.

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