

Evolution and trends in the research on the production of organic avocados: a bibliometric assessment (1990-2023)

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ABSTRACT

Objective: Analyze the scientific research on organic avocados globally between 1990 and 2023.

Design/methodology/approach: A bibliometric analysis was conducted using the Scopus database to assess the number of studies, citations, publication type, language, studies by country, affiliations, authors, research areas, and keywords.

Results: 294 documents were found, of which 83% were scientific articles published in 153 journals, 95% were written in English, and 162 researchers affiliated with 154 institutions from 64 countries. The documents covered 24 research fields and were grouped into three keywords: laboratory, growth, and orchard.

Limitations on study/implications: Only Scopus was used as a data source, which could have limited the number of gathered studies.

Findings/conclusions: Research on organic avocados has grown steadily globally during the evaluated period. Mexican researchers and institutions have led the production of documents in a wide variety of research fields, which shows the potential to conduct further interdisciplinary research on organic avocados.

Keywords: Agriculture, environment, Scopus, Organic, Bibliometric.

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INTRODUCTION

According to Sanders *et al.* (2025), organic farming represents a systemic and holistic approach to production grounded in ecological principles, promoting agricultural practices that respect biological cycles and the natural limits of ecosystems. Additionally, various studies have shown that this production model generates significant environmental benefits and contributes to improving animal welfare, particularly in temperate climate regions. Similarly, Canwat and Onakuse (2023) define organic farming as a certified system that preserves soil health, ecosystems, and human well-being, using ecological processes, biodiversity, and adapted cycles without relying on harmful inputs. Avocado (*Persea americana* Mill.) cropping has grown during the last 30 years, mainly in Mexico, the leading producer since 1961, and other countries such as Colombia, Peru, Dominican Republic, and Kenya (FAOSTAT, 2024). However, the conventional production of avocado



has triggered environmental issues, such as the overuse of agrochemicals, deforestation, biodiversity loss, and displacement of wildlife (Denvir *et al.*, 2022), particularly in the highlands of the state of Michoacán, the worldwide core of avocado production (Sáenz-Ceja & Pérez-Salicrup, 2021). Hence, the interest in the production of organic avocados has increased as a more sustainable alternative (Ortega-Gómez *et al.*, 2022).

Research on organic avocados has grown alongside organic production since it provides knowledge and technology to improve the productivity, sustainability, and quality of organic avocado production. In this context, various studies confirm that compost, manure, and biofertilizers enhance soil fertility and the yield of organic avocados. Vermicompost, for example, increases nitrogen, phosphorus, and potassium —key nutrients for cultivation. These sustainable methods boost productivity while preserving soil health (Silber *et al.*, 2018). Additionally, Tesfay *et al.* (2017) note that these sustainable practices enhance productivity while maintaining soil health. Some studies also suggest that organic avocados may have higher concentrations of antioxidant compounds, such as phenols, although with slightly lower yields compared to conventional systems. Similarly, it has been documented that organic production results in lower CO₂ emissions compared to conventional methods, especially when synthetic fertilizers are avoided (Notarnicola *et al.*, 2017). However, trends and the evolution of organic avocado research need to be understood. In this sense, due to the availability of scientific databases, bibliometry has become a fundamental tool to provide an overview of a research field, identify areas of opportunity for conducting research, and detect emerging research topics (Donthu *et al.*, 2021). Therefore, this study aimed to assess the development of research on organic avocados globally, identify trends in this research field, and identify emerging areas of opportunity, under the hypothesis: research on organic avocado production has steadily grown over the past three decades, reflecting a global shift toward sustainable agriculture.

MATERIALS AND METHODS

A bibliometric analysis was conducted by searching for studies indexed in the Scopus database with the keywords “organic” and “avocado” for the years 1990 to 2023 globally. It is important to note that Scopus was chosen for its multidisciplinary coverage, rigorous indexing criteria, and compatibility with bibliometric tools. Its reliability for scientific analysis is well-established (Mongeon & Paul-Hus, 2016; Baas *et al.*, 2020), offering key methodological advantages for this study. On the other hand, the implementation of NAFTA in 1994 marked a turning point in global avocado production by eliminating tariff barriers and positioning Mexico as the world’s leading exporter (Denvir *et al.*, 2022). This agreement spurred exponential growth in avocado cultivation, with a 500% increase in production between 1990 and 2023 (FAO, 2023), solidifying the avocado as a strategic commodity in the international agricultural market. Then, we assessed the number of documents, citations, publication type, language, documents by country, affiliations, authors, research fields, and keywords. The analysis covered all available research areas to ensure a multidisciplinary approach, and no filters were applied based on document type during the data collection, meaning 100% of the documents found were considered. To avoid duplicate entries in Scopus, a verification of unique identifiers,

such as the DOI, was performed, along with a manual cleanup of the exported records prior to the bibliometric processing. The documents by country were mapped with QGIS version 3.22-Białowieża, and the keyword analysis was performed in VOSviewer 1.6.20 to obtain an analysis of the co-occurrence of keywords. VOSviewer was used for its ability to analyze and visualize bibliometric networks, such as the co-occurrence of keywords, authors, and countries. Its compatibility with Scopus and intuitive interface make it an effective tool for identifying thematic clusters and structural relationships in scientific production (Van Eck & Waltman, 2010). Keyword co-occurrence analysis involves identifying terms that appear together across multiple documents, enabling the visualization of thematic relationships, conceptual clusters, and research trends within a specific scientific field (Callon *et al.*, 1991).

RESULTS AND DISCUSSION

During the evaluated period (1991-2023), a total of 294 documents were published, showing a statistically significant exponential growth trend ($R^2=0.80$; $RMSE=4.69$). On average, 8.8 documents were published annually over the entire period. However, from 2017 to 2023, this figure increased sharply to an average of 25.1 documents per year. In 2023 alone, 41 publications were recorded. Regarding citations, the yearly average remained below 6, with a cumulative total of 62.8 citations across the entire period. Notably, 56% of all citations occurred between 2011 and 2019, indicating a concentrated impact during that timeframe (Figure 1).

According to the document type, 83.3% of the studies were research articles. Other document types were conference papers (10.9%), reviews (3.7%), and book chapters (2%) (Figure 2).

The research articles were published in 153 journals, of which *Acta Horticulturae*, *Scientia Horticulturae*, *IOP Conference Series Earth and Environmental Science*, *Journal Of Chromatography A*, *Molecules*, and *Food Chemistry* concentrated 15.4% of the published articles. Table 1 shows the ten most relevant journals.

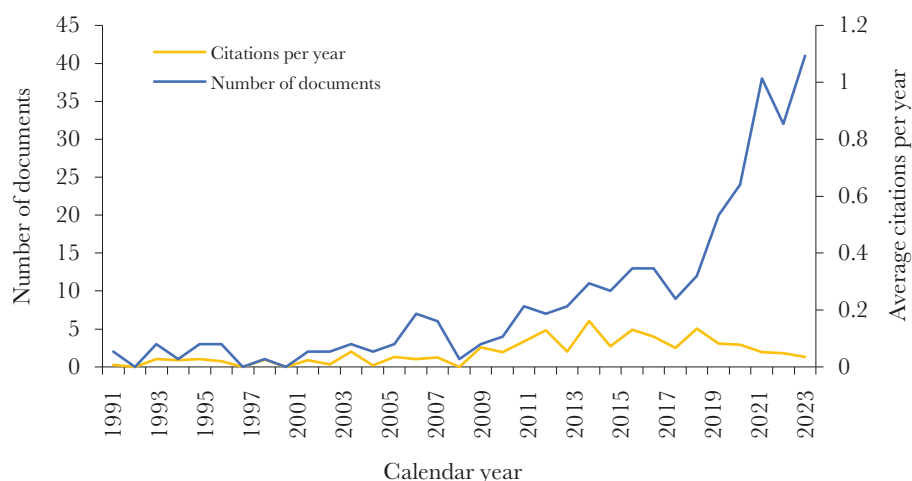


Figure 1. Number of documents and citations per year on organic avocado between 1990 and 2023 globally.

Table 1. Documents by journal.

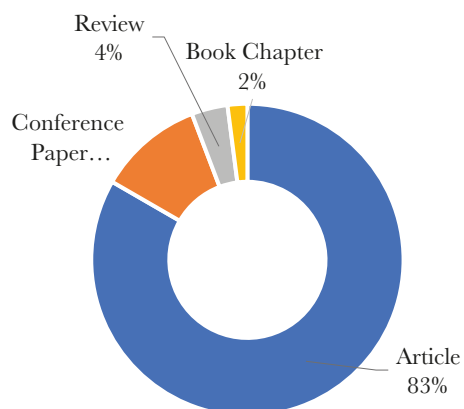
Journal	Documents
Acta Horticulturae	13
Scientia Horticulturae	8
IOP Conference Series Earth and Environmental Science	7
Journal of Chromatography A	7
Molecules	6
Food Chemistry	5
Food Research International	4
Frontiers in Microbiology	4
Journal of Agricultural and Food Chemistry	4
Agronomy	3

Furthermore, 95% of the documents on organic avocados were written in English, whereas only 2.4% were published in Spanish, and the rest in Portuguese, French, and Italian (Table 2).

The origin of the documents was distributed in 64 countries (Figure 3), of which Mexico stood out with 55 documents, followed by the United States of America (45 documents), Spain (40 documents), Indonesia (21 documents), Brazil (20 documents), and Chile (10 documents), which together concentrated 65% of the published documents.

Table 2. Language of documents.

Language	Documents
English	283
Spanish	7
Portuguese	4
French	2
Italian	1

**Figure 2.** Percentages of documents on organic avocados according to document type.

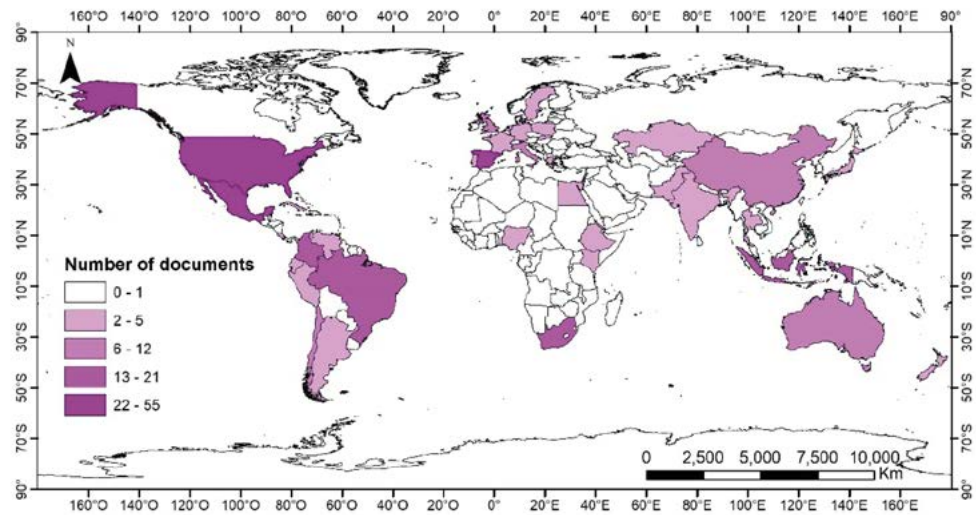


Figure 3. Number of documents on organic avocados according to the country of origin.

In addition, 24 research fields were identified, of which the agricultural and biological sciences represented 28.2% of the total studies, with an annual mean of 4.5 studies. It is followed by chemistry (11.7%), environmental sciences (10.4%), biochemistry, genetics, and molecular biology (10%). The ten most important research fields related to organic avocados are shown in Table 3.

A total of 162 authors and 154 affiliations were found, and among the most prolific authors stood out Francisco Cazorla, Edgar Guevara-Avedaño, Ana Luisa Kiel-Martínez, and Frédérique Reverchon. Each one had six published documents, representing 6% of the total documents. The 16 most prolific authors are shown in Table 4.

Figure 4 shows the main terms, representing nodes, whose size is associated with their occurrence, whereas the lines connecting nodes represent the strength between these terms: the more density of lines, the more frequent this relationship is. The keywords

Table 3. Documents by research field.

Subject area	Documents
Agricultural and biological sciences	149
Chemistry	62
Environmental sciences	55
Biochemistry, genetics and molecular biology	53
Chemical engineering	34
Immunology and microbiology	25
Engineering	19
Physics and astronomy	18
Medicine	17
Energy	16

Table 4. Documents by author and affiliation.

Author	Documents	Affiliation
Cazorla, Francisco	6	Universidad de Málaga, Spain
Guevara-Avenidaño, Edgar	6	Instituto de Ecología, A.C., Mexico
Kiel-Martínez, Ana L.	6	Instituto de Ecología, A.C., Mexico
Reverchon, Frédérique	6	Instituto de Ecología, A.C., Mexico
Carrasco-Pancorbo, Alegria	5	Universidad de Granada, Spain
Guerrero-Analco, José A.	5	Instituto de Ecología, A.C., Mexico
Ramírez-Vázquez, Monica	5	Instituto de Ecología, A.C., Mexico
de Vicente, Antonio	5	Universidad de Málaga, Spain
Fernández-Gutiérrez, Alberto	4	Universidad de Granada, Spain
Hurtado-Fernández, Elena	4	Universidad Loyola, Spain
Menge, John A.	4	University of California, United States
Méndez-Bravo, Alejandro	4	UNAM Campus Morelia, Mexico
Ramírez-Gil, Joaquín G.	4	Universidad Nacional de Colombia, Colombia
Sivasithamparam, Krishnapillai	4	Murdoch University, Australia
Vida, Carmen	4	Universidad de Málaga, Spain
Astier, Marta	3	UNAM Campus Morelia, Mexico

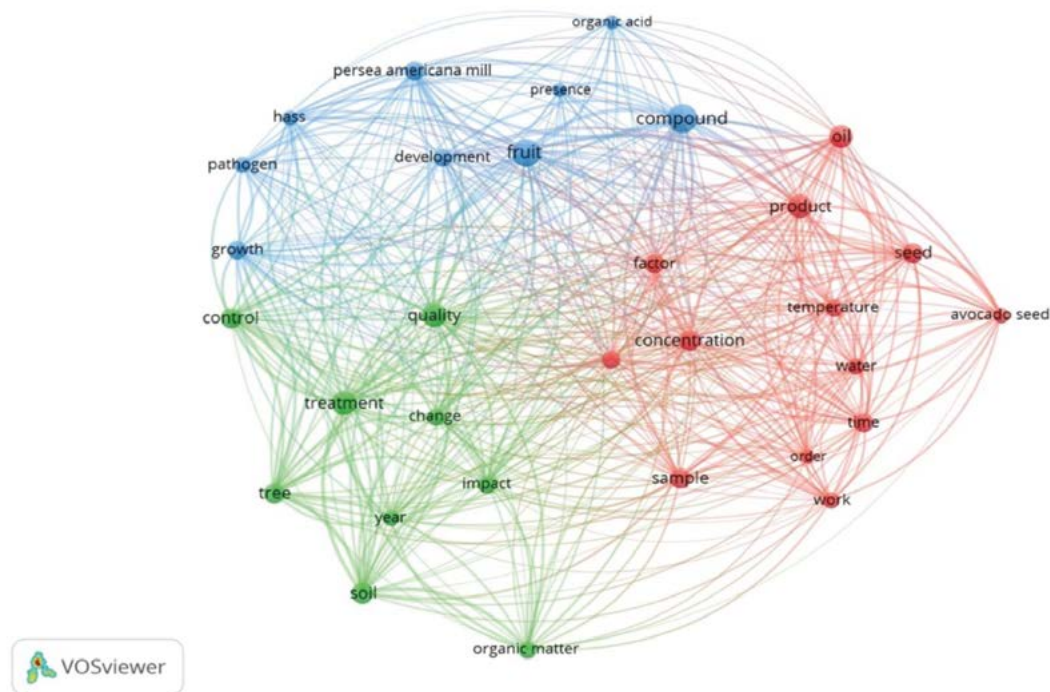


Figure 4. Co-occurrence network of keywords related to organic avocados from the Scopus database.

analysis revealed three great groups, according to the number of clusters of words whose co-occurrences appeared in the evaluated documents. The three clusters are the following: The red cluster shows terms associated with the laboratory, such as concentration, seed,

sample, and product. The green cluster draws words associated with orchards, such as quality, treatment, control, tree, impact, and organic matter. Moreover, the blue cluster revealed words associated with growth variables, for example, *Persea americana* Mill., compound, development, fruit, and growth.

Research on organic avocados has grown steadily since 1990, which reveals the relevance of this research topic related to the environmental and economic importance of organic avocados. Moreover, this trend can be associated with seeking sustainable solutions to climate change, deforestation, pollution, and biodiversity loss related to the conventional production of avocados (Denvir *et al.*, 2022). Also, since 2017, the number of documents has increased substantially, which can be explained by the implementation of the 17 Sustainable Development Goals in 2015, supported by 193 countries, which has boosted environmental research, including organic avocado (ONU, 2024).

However, the number of documents on organic avocados is relatively low compared to other crops. For example, for the same evaluated period (1990-2023), there were 3,556 studies on organic coffee, 1,668 documents on organic strawberries, and 993 on organic peaches (Scopus, 2024). This comparative analysis notes the necessity of conducting more studies on organic avocados.

As the world's leading avocado producer, Mexico's production is primarily concentrated in conventional systems (SIAP, 2023). However, climate change and increasing environmental pressures have spurred interest in more sustainable systems, such as organic farming (Notarnicola *et al.*, 2017). Recent studies highlight the potential of organic avocado production to better adapt to adverse climatic conditions, facilitating its transition from conventional practices.

Furthermore, Mexico stands out by the number of documents on organic avocados, which in turn leads to the production of organic avocados. Nonetheless, it is curious that most documents have been written in English, which can be explained because it is the language of science (Drubin & Kellogg, 2012). Similarly, most documents have been published as research articles, which are the academic way to disseminate research findings, in which journals such as *Acta Horticulturae* and *Scientia Horticulturae* stand out as two forums relevant to sharing findings on organic agriculture.

Nonetheless, the scientific production of organic avocados in Mexico is limited compared to other countries that have invested significantly in organic crops, such as apples and strawberries in the United States of America (FiBL, 2024). Mexico lacks this kind of investment, which could have reflected the low number of documents. Hence, it is crucial to boost scientific research on organic avocados, considering their ecological relevance and potential for sustainable development.

This bibliometric assessment has shown that many research fields are related to organic avocados, which points out the interdisciplinary nature of organic avocado research. This could be an opportunity to increase the scientific production of this crop, integrating fields such as biotechnology, food science, and sustainability through collaborative approaches (Marra *et al.*, 2024). Emerging research topics, such as avocado sub-products (shells, seeds), could contribute to interdisciplinary studies looking for the reduction of residues and the creation of functional food ingredients.

Studies on organic avocado highlight its potential to improve global agricultural sustainability by reducing CO₂ emissions and enhancing soil health (Notarnicola *et al.*, 2017; Silber *et al.*, 2018). In Mexico, as the world's leading avocado producer, adopting these practices is crucial to address the environmental challenges associated with intensive production. Promoting organic farming could not only position the country as a leader in sustainable practices but also strengthen its access to international markets with high demand for organic products.

To support this transition, Mexico could implement subsidies and support to promote organic farming. This would include direct subsidies for transitioning to organic practices, payments for environmental services that reward the adoption of sustainable practices, and partial funding for organic certification. Additionally, tax incentives, such as exemptions or deductions, could be offered, along with the development of insurance programs specifically for organic products, providing financial security for producers. It would also be beneficial to create funds for technological innovation in organic farming and subsidies to facilitate the marketing and export of organic products, helping position Mexico as a global leader in this sector.

CONCLUSIONS

This is the first bibliometric assessment on organic avocados, providing a global overview of this research field, which has experienced steady growth during the last 33 years. However, this study also revealed that the number of documents is low compared to other organic crops. Mexico is the country leading the scientific research and, in turn, the production of organic avocados. Moreover, this assessment shows that the interdisciplinary nature of organic avocado research could be an opportunity to increase the number of studies, which is crucial considering the negative impacts of conventional avocado production.

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