



META-ANALYSIS OF SCIENTIFIC INFORMATION ON THE SPECIES *CARLUDOVICA PALMATA* RUÍZ & PAVÓN

META-ANÁLISIS DE LA INFORMACIÓN CIENTÍFICA SOBRE LA ESPECIE *CARLUDOVICA PALMATA* RUÍZ & PAVÓN

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Abstract

Carludovica palmata Ruíz & Pavón is a palm species with great potential in the manufacture of handicrafts, but with limited agricultural management. It is native to Ecuador, and in Mexico it is only distributed in Campeche in the southeast of the country; it serves as raw material for manufacturing Jipi palm hats. The objective of this work is to analyze the spatio-temporal evolution of research published in scientific articles where the species was studied, using bibliometric techniques to identify areas of opportunity in research that have been little developed. We found 78 texts from 1961 to 2022 whose spatio-temporal evolution showed an exponential growth that concentrated in countries of America: Colombia (38), Mexico (11) and Ecuador (8). The most recurrent research topics were botany of the species (20), transformation of its fibers into handicrafts (18), traditional production (*in situ* cultivation) (17) and commercialization of handicrafts (15). However, a null development of propagation techniques of the species was found, a problem that is accentuated if one considers the high demand for its specimens for the manufacture of handicrafts. Therefore, little explored areas of research such as *in vitro* propagation can contribute to the supply of the raw material of an emerging market on products and by-products of the jipi palm. In the case of Mexico, the research focused on the southeast, which coincides with the region where the species is cultivated, but which showed a lack of development in techniques on its propagation.

Keywords: Bibliometric analysis, Campeche, iraca palm, jipi palm, jipijapa palm, toquilla straw.

Resumen

Carludovica palmata Ruíz & Pavón es una especie de palma con amplio potencial en la manufactura de artesanías, pero con limitado manejo agrícola. Es originaria de Ecuador, y en México solo se distribuye en Campeche al sureste del país; sirve como materia prima para la fabricación de los sombreros de palma jipi. El objetivo de este trabajo es analizar la evolución espacio-temporal de la investigación publicada en artículos científicos donde la especie fue objeto de estudio, mediante técnicas bibliométricas para identificar áreas de oportunidad en investigación que han sido poco desarrolladas. Se encontraron 78 textos de 1961 a 2022 cuya evolución espacio-temporal mostró un crecimiento exponencial que se concentró en países de América: Colombia (38), México (11) y Ecuador (8). Los temas de investigación más recurrentes fueron: botánica de la especie (20), transformación de sus fibras en artesanías (18), producción tradicional (cultivo *in situ*) (17) y comercialización de las artesanías (15). Sin embargo, se encontró un nulo desarrollo de técnicas de propagación de la especie, un problema que se acentúa si se considera la alta demanda de sus ejemplares para la fabricación de artesanías. Por lo que áreas de investigación poco exploradas como la propagación *in vitro* pueden contribuir al abastecimiento de la materia prima de un mercado emergente sobre productos y subproductos de la palma jipi. Para el caso de México, la investigación se focalizó en el sureste, que coincide con la región donde se cultiva la especie, pero que evidenció un nulo desarrollo en técnicas sobre su propagación.

Palabras clave: Análisis bibliométrico, Campeche, palma iraca, palma jipi, palma jipijapa, paja toquilla.

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1 Introduction

Carludovica palmata Ruiz & Pavón, also known as *palma jipi* in Mexico, *paja toquilla* or *jipijapa* in Ecuador, and *iraca* in Colombia, is a member of the Cy-clanthaceae family cultivated from southern Mexico to northern Bolivia, with a notable presence in Colombia, Panama, and Ecuador (where it is considered native) (Bennett et al., 1992). This palm is valued for its soft, flexible, and durable fibers, which are woven to create hats and other handicrafts (Galviz et al., 2019). These handicrafts are mostly sold in local markets and contribute to the economy of rural producers, for whom the palm has significant cultural importance (Fadiman, 2001).

Several studies have been conducted on *C. palmata*, describing the botany of the species (López et al., 2013; Garcés et al., 2017), its cultural relationship with ethnic groups such as the Quechua in Ecuador (Bennett et al., 1992) and the Maya in Mexico (Fadiman, 2001). Research has also addressed pests and diseases affecting its cultivation (Cordova et al., 2000; Franz and O'Brien, 2001), biotechnology techniques to enhance fiber quality in the transformation process into handicrafts (Ortega et al., 2012; Galviz et al., 2019), and even *in vitro* propagation processes (Hoyos-Sánchez et al., 2020).

However, despite these publications and the cultural and economic significance of the species for agricultural producers and artisans in the regions where *C. palmata* is cultivated, little research has focused on the species as a primary subject of study (Galviz et al., 2019). This phenomenon may largely be due to its status as a local resource with recently gained commercial value, primarily associated with the artisanal production of hats as its sole product (Ortega et al., 2012).

In this context, to understand the research developed around a specific topic and identify opportunities for generating new knowledge, bibliometric studies based on scientific article analysis can be a valuable tool (Cañas-Guerrero et al., 2013). Publishing a scientific study is the most effective way to communicate acquired knowledge resulting from research, and bibliometric analysis can generate indicators to measure the outcomes of scientific and technological activity (Allen et al., 2009). Understanding the scientific information

published on a particular topic allows for informed decision-making regarding its improvement and helps identify underexplored research areas (Martínez-Santiago et al., 2017). Bibliometric studies have been applied to species with recently acquired commercial value, such as *Brosimum alicastrum* Swartz (Espinosa-Grande et al., 2023), as well as globally significant crops like maize (Santillán-Fernández et al., 2021), wheat (Giraldo et al., 2019), and rice (Sun and Yuan, 2020).

However, despite the potential of bibliometric studies to bridge knowledge gaps on a particular topic or species, research on *C. palmata* still has unexplored areas where bibliometric analysis could contribute. In this context, the objective of this study is to analyze the spatial-temporal evolution of research published in scientific articles where *C. palmata* was the subject of study, using bibliometric techniques to identify research opportunities that have been insufficiently explored.

2 Materials y Methods

2.1 Origin of the information

In this study, scientific articles in which the species *C. palmata* was the primary subject of research were considered. Through a content analysis, studies where the species was only mentioned but not analyzed in depth were omitted. The keywords used in the search for scientific articles were *Carludovica palmata* Ruiz & Pavón, *palma iraca*, *palma jipi*, and *paja toquilla*.

Scientific articles available from major publishers (Elsevier, Scopus, and Springer), open-access journal article databases (Conricyt, Scielo, Redalyc, Latindex, Clarivate Analytics, Periodica, and DOAJ), and the freely accessible web search engine Google Scholar were considered. Additionally, the “snowball” technique was applied to retrieve missing articles by reviewing the reference lists of initially identified studies (Leipold, 2014). The scientific articles were collected between January and February 2023, and texts available up to December 2022 were included.

2.2 Information analysis

Through a content analysis, the variables evaluated for each scientific article included: author names, year of publication, number of citations, title, text summary, keywords, journal name, institutional affiliation of the first author, country of origin of the first author, and the research area where the study was conducted. The data was recorded in a spreadsheet while maintaining the original language of each text. During data entry, some records were standardized, and special characters were removed or replaced to facilitate analysis, including: “ñ” (changed to “n”), accents, superscripts, subscripts, ®, ©, among others (Aguado-López et al., 2009). Following the methodology of Santillán-Fernández et al. (2021), Espinosa-Grande et al. (2023), and Santillán-Fernández et al. (2023), temporal graphs of scientific production were created using the variables year of publication and number of citations.

Additionally, an ordinary least squares regression model was estimated to determine trends in publication frequency (Gujarati, 2007). Given that the first author bears the primary responsibility for writing and publishing a scientific article (Aguado-López et al., 2009), the countries of origin of the first author were geographically mapped alongside the research areas to identify where research on the *C. palmata* species is being conducted. For this purpose, the geographic software ARGIS[®] (ESRI, 2021) was used.

A content analysis of the article titles, abstracts, and keywords was conducted to determine the thematic focus of each text. This classification was based on the system proposed in Scopus (2023) for the *C. palmata* species. Additionally, experts from the Autonomous University of Yucatán (1) and the Postgraduate College, Campeche campus (2) were interviewed. Seven thematic categories were established: (1) Transformation, which included studies associated with the use of the palm in handicraft production; (2) Traditional production, encompassing studies related to the cultivation of the species through conventional agronomic management; (3) *In vitro* production, referring to studies on plant reproduction under artificial environments; (4) Commercialization, comprising studies on producer or-

ganization, value addition, sales, distribution, and export of products and by-products derived from the species; (5) Botany, including studies related to the taxonomy of the species; (6) Pests and diseases, focused on the pests and diseases affecting the crop; and (7) Anthropology, addressing the cultural significance of the species in the communities where it is distributed.

Once the scientific articles were categorized by topic, a thematic graph was created based on the first author's country of origin and the temporal distribution of the topics. This aimed to identify potential areas for new research on the *C. palmata* species by country. Finally, bibliometric indicators were generated to identify the most relevant scientific articles, authors, and journals publishing on the species. Using the authors' names, co-authorship networks were constructed in Gephi software (Bastian et al., 2009). Additionally, the variables first author's country, first author's institutional affiliation, research areas, and citations were analyzed to determine the most relevant scientific articles based on citation count, as well as the institutions and research areas by country that have contributed to knowledge on the species. In the case of Mexico, all institutions (of both first authors and collaborators) conducting research on the species were spatially mapped alongside the regions where it is cultivated.

3 Results and Discussion

3.1 Spatiotemporal analysis

From 1961 to 2022, a total of 78 scientific articles were published in which the *C. palmata* species was the subject of study. This body of scientific work generated 356 bibliographic citations (Figure 1). The first recorded study dates back to 1961. However, from 2001 onward, there was a growing trend in research on the species. The most productive period was from 2001 to 2021, accounting for 76.92% of the total publications (60), which contributed to an exponential growth trend in publications ($R^2 = 0.2785$). The most cited works were those published between 1961 and 2001, collectively accounting for 61.80% of total bibliographic citations (220).

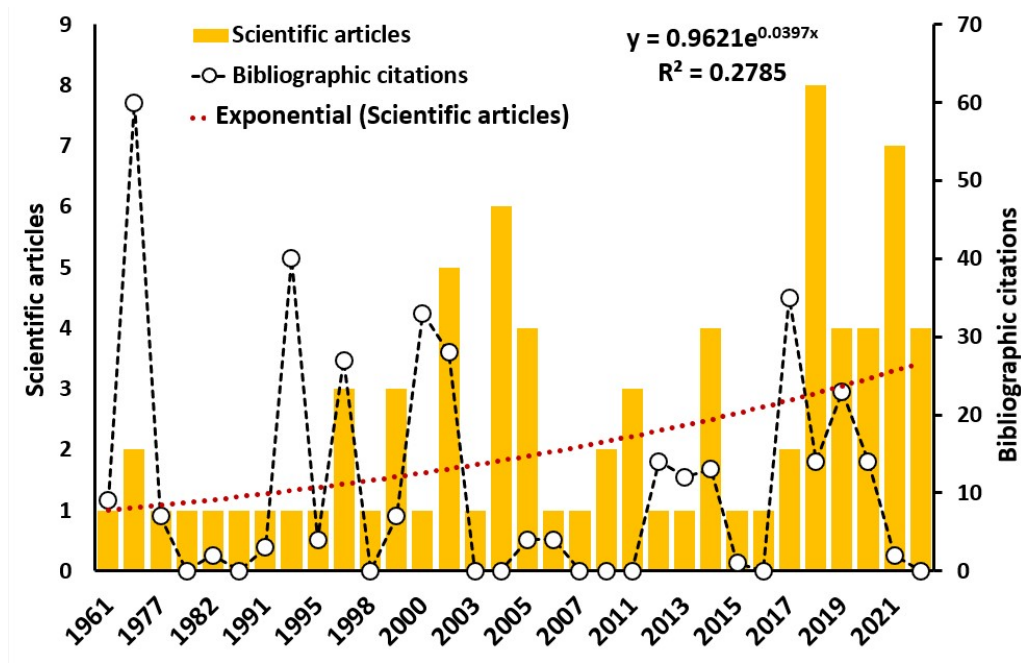


Figure 1. Temporal evolution of scientific production and bibliographic citations where the *C. palmata* species was the subject of study from 1961 to 2022.

Poot-Pool et al. (2018) attribute this increase in the number of publications to the recent commercial value of the species as a raw material for regional handicrafts in Latin America, where it originates. This commercial value has made *C. palmata* a recurrent research topic in southeastern Mexico, Central America, and South America, as it serves as a local resource that supports the economic development of rural regions where it is found (Galviz et al., 2019). However, Ortega-Haas et al. (2020) found that further research is needed on the cultivation of the species to ensure a sustainable supply of raw material for the economic activities that depend on it.

Based on the country of origin of the first author of the scientific articles, the 78 studies originated from 12 countries: Colombia (48.72%, 38 texts), Mexico (14.10%, 11), Ecuador (10.26%, 8), the United States of America (7.69%, 6), Costa Rica (6.41%, 5), Peru (5.13%, 4), Germany (1.28%, 1), Austria (1.28%, 1), Brazil (1.28%, 1), Canada (1.28%, 1), Spain (1.28%, 1), and Nicaragua (1.28%, 1) (Figure 2). Figure 2 shows that the majority of research on *C. palmata* has been conducted in Latin American

countries (68 texts, 87.18%). Additionally, the study areas of the 78 analyzed articles were geographically located within this region of the Americas. This is explained by the fact that the species' center of origin is in the province of Manabí, Ecuador (Ruiz and Pavón, 1798), from where it has spread to southeastern Mexico, Central America, and the Amazon region in South America (Bristol, 1961).

The research studies that contributed the most knowledge about the *C. palmata* species were: Botany (20 texts, 25.64%), Transformation (18, 23.09%), Traditional production (17, 21.79%), and Commercialization (15, 19.23%), collectively representing 89.75% (70 texts) (Table 1). However, during the analysis period (1961–2022), it was observed that although the earliest studies focused on the Botany of the species (1961), it was not until 1978 that scientific articles on transformation and commercialization emerged. From 1987 onward, publications related to cultivation began to appear, followed by studies on agronomic management in 2000. Additionally, it is noteworthy that the first research on propagation techniques in artificial environments (*In Vitro* Production) appeared in 2020.

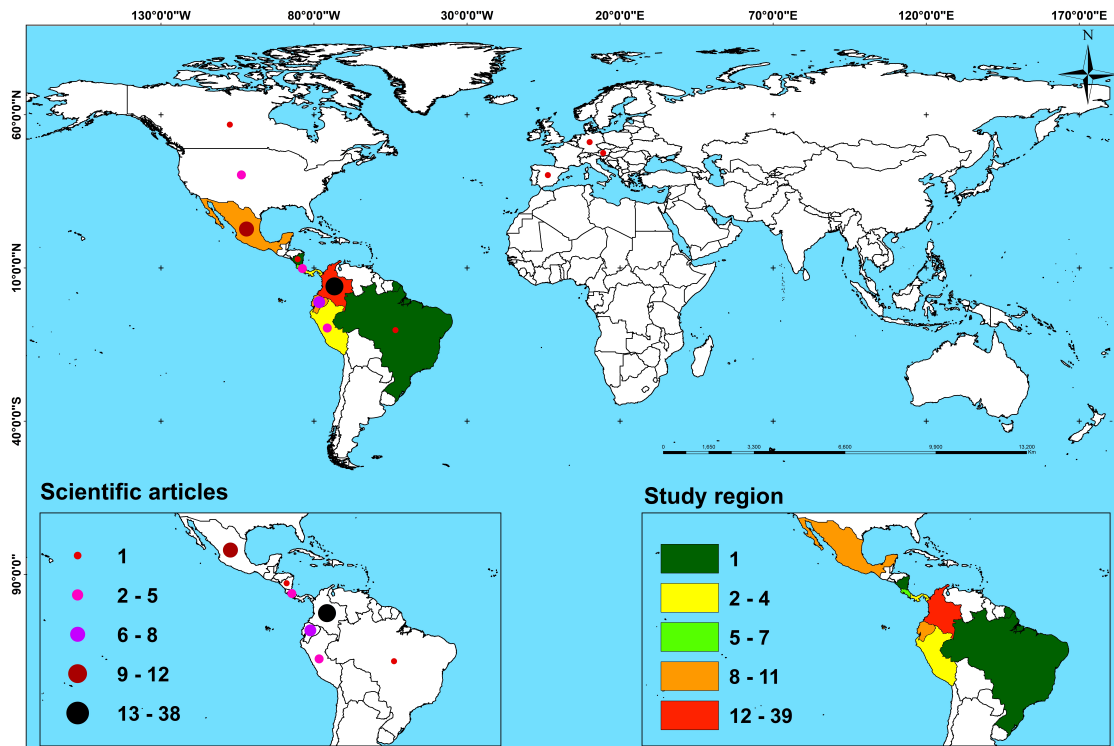


Figure 2. International spatial distribution of study areas and scientific text productivity where the *C. palmata* species was analyzed from 1961 to 2022.

In nine of the twelve countries that conducted research on *C. palmata*, the topic of Botany was recurrent (Figure 3). In contrast, topics related to its traditional cultivation were only found in four countries (Colombia, Mexico, USA, and Canada), with Colombia and Mexico being the only countries where *in situ* cultivation has been reported (Ortega-Haas et al., 2020). Regarding studies on the *in vitro* propagation of the species, only Colombia has reported advancements in this area. Therefore,

in the case of Mexico, topics such as *in vitro* propagation, agronomic management of the species, and commercialization models remain unexplored areas. According to Espinosa-Grande et al. (2023), when the uses of a local species are enhanced, the main challenge is to conduct research on its sexual or asexual reproduction to ensure a stable supply of raw materials for the economic activities developed around the species.

Table 1. Timeline of research topics developed around the *C. palmata* species from 1961 to 2022.

Topic	Scientific Articles		Period
	Number	%	
Botany	20	25.64	1961-2022
Transformation	18	23.09	1978-2021
Traditional Production	17	21.79	1987-2022
Commercialization	15	19.23	1978-2021
Anthropology	4	5.13	1992, 2001
Pests and Diseases	2	2.56	2000-2001
<i>In Vitro</i> Production	2	2.56	2020, 2022
Total	78	100	1961-2022

3.2 Bibliometric Indicators

Of the 78 scientific articles, 79.49% (62 texts) were published in Spanish, while 20.5% (16) were in English. Among the 356 bibliographic citations, 24.44% (87) corresponded to texts published in Spanish, whereas 75.56% (269) were from texts in English. According to Li and Zhao (2015), English has been adopted as the universal language of the scientific community, making publications in English more likely to be disseminated internationally. In fact, eight of the ten most cited scientific articles were published in English (Table 2). Collectively, these eight articles accounted for 62.08% of the total bibliographic citations (221) and were mostly published in journals with impact factors above 3. Santillán-Fernández et al. (2021) found that the impact factor of journals increases the probability of reaching a wider audience.

Regarding the research topics covered in the ten most cited articles, studies focusing on the cultural importance of *C. palmata* in indigenous communities in Ecuador (Quechua) and Mexico (Maya) stood out. Additionally, studies on pests and diseases were prominent, with research conducted in countries where the species is cultivated *in situ* (Mexico and

Ecuador). Consequently, cultural aspects and agronomic management of cultivation present opportunities for generating new knowledge. Table 2 also shows that five of the ten most cited studies were conducted by authors whose country of origin was different from the study area (USA: 4, Canada: 1).

Table 3 reveals that in the countries where *C. palmata* is naturally distributed (Colombia, Mexico, Ecuador, Costa Rica, Peru, Nicaragua, and Brazil), research institutions conducting studies on the species geographically locate their research areas within their own territory. This does not occur in European countries (Germany, Austria, and Spain), the USA, or Canada. Gersbach and Schneider (2015) found that economically developed countries such as the USA and European nations invest more in their research centers, enabling them to conduct studies beyond their national borders. Additionally, Espinosa-Grande et al. (2023) observed that in studies on locally significant species, the production of new knowledge by researchers from outside the study areas is common. Therefore, strengthening international co-authorship networks presents a viable strategy for generating new knowledge in regions of interest through external investments (Aguado-López et al., 2009).

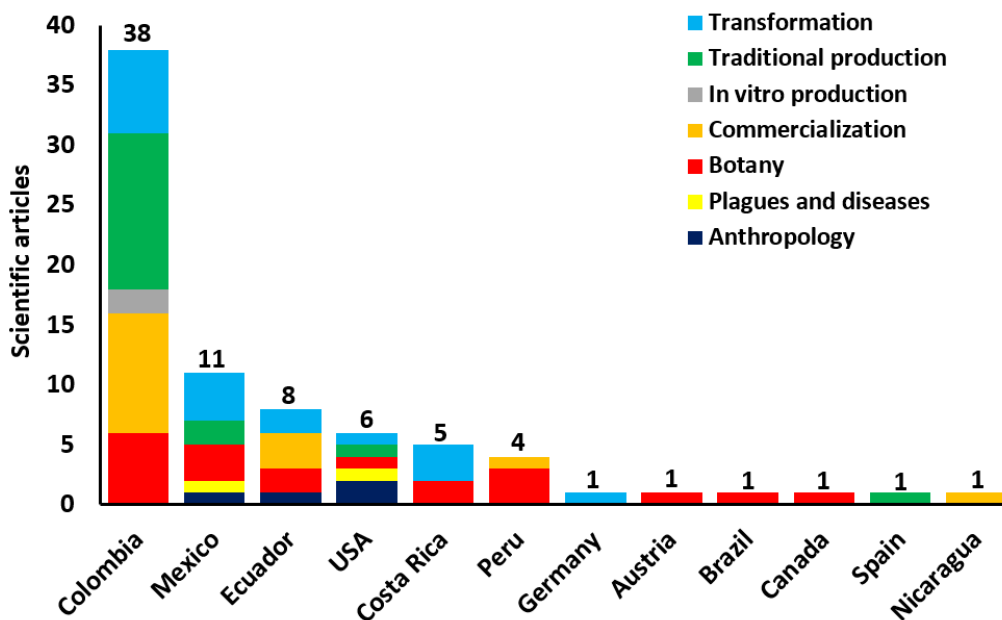


Figure 3. Research topics of the main nations that published scientific articles where the *C. palmata* species was studied from 1961 to 2022.

Table 2. Bibliometric indicators of the main scientific articles where the species *C. palmata* was the subject of study from 1961 to 2022, ordered according to the number of bibliographic citations.

Author	First author		Country	Name	Scientific journal		Topic	Area of Study
	Institution	Country			JCR (WoS, 2021)	Lenguaje		
Bennett et al. (1992)	Jardín Botánico de NY	USA	Economic Botany	Q2 / 2.6	English	35	Anthropology	Ecuador
Cordova et al. (2000)	CICY	Mexico	Plant Disease	Q1 / 4.6	English	37	Pests and diseases	Mexico
Garcés et al. (2017)	PUCE	Ecuador	Frontiers in Microbiology	Q1 / 6.1	English	37	Botany	Ecuador
Wilder (1976)	Universidad de Illinois	USA	American Journal of Botany	Q1 / 3.3	English	34	Botany	Panama
Anderson and Gomez (1997)	MuCaNa	Canada	Revista de Biología Tropical	Q3 / 0.8	English	21	Botany	Costa Rica / Panama
Galviz et al. (2019)	UNC-Medellín	Colombia	Food and Bioproducts Processing	Q1 / 5.1	English	27	Transformation	Colombia
Franz and O'Brien (2001)	Universidad de Cornell	USA	A_ Entomological _SA	Q2 / 2.7	English	20	Pests and diseases	Costa Rica / Panama / Ecuador
Ortega et al. (2012)	Liceo Bella Suiza	Colombia	UDCA	No tiene	Spanish	14	Transformation	Colombia
López et al. (2013)	UPS	Ecuador	Ingenius Economic Botany	No tiene	Spanish	12	Botany	Ecuador
Fadiman (2001)	Universidad de Texas	USA	Economic Botany	Q2 / 2.6	English	10	Anthropology	Mexico

NY: New York; CICY: Centro Investigaciones Científicas de Yucatán; PUCE: Pontificia Universidad Católica del Ecuador; MuCaNa: Canadian Museum of Nature; UNC-Medellín: Universidad Nacional de Colombia Sede Medellín; UPS: Universidad Politécnica Salesiana; UDCA: Revista UDCA Actualidad & Divulgación Científica; Ingenius: Revista de Ciencia y Tecnología; A_ Entomological _SA: Annals of the Entomological Society of America; USA: United States of America.

Table 3. Association of the main research institutions and their study areas by country, which have published scientific articles where the *C. palmata* species was the subject of study.

Country	Institutions	Study Area
Colombia (38)	UNC-Medellín (13)	Nariño, Colombia (8)
	Universidad de Antioquia (9)	Usiacurí, Colombia (7)
	Universidad de Nariño (8)	Medellín, Colombia (5)
	PU-Javeriana (4)	Chocó, Colombia (4)
	Colegio Liceo bella Suiza (1)	Bolívar, Colombia (4)
	Universidad de Córdoba (1)	Boyacá, Colombia (3)
	UC-Barranquilla (1)	Sucre, Colombia (3)
	Universidad de los Andes (1)	Lorica, Colombia (3) Huila, Colombia (1)
Mexico (11)	CICY (4)	Campeche, Mexico (11)
	IT-Chiná (2)	
	ECOSUR-Cam (2)	
	IT-Mérida (1)	
	ITS-Calkiní (1)	
	UA-NLeón (1)	
Ecuador (8)	Universidad Politécnica Salesiana (5)	Manabí, Ecuador (5)
	PUCE (2)	Cuenca, Ecuador (3)
USA (6)	Universidad del Azuay (1)	
	Universidad de Illinois (1)	Mexico (1)
	Jardín Botánico de NY (1)	Colombia (2)
	Universidad de Cornell (1)	Costa Rica (1)
	Universidad de Texas (1)	Panama (1)
	Universidad de Harvard (1)	Ecuador (1)
Costa Rica (5)	Universidad Estatal de Cleveland (1)	
	CATIE-CR (3)	Puntarenas, Costa Rica (3)
	Universidad de Costa Rica (1)	Cartago, Costa Rica (2)
Perú (4)	Universidad Nacional de Costa Rica (1)	
	UNCP (2)	Ucayali, Perú (3)
Nicaragua (1)	UNIA (2)	Lima, Perú (1)
	UNA-Camoapa	Nicaragua (1)
Germany (1)	Universidad de Ulm (1)	Guyana Francesa (1)
Austria (1)	Universidad de Viena (1)	Costa Rica (1)
Brazil (1)	Universidad Estatal Paulista (1)	Brasil (1)
Canada (1)	Museo canadiense de la naturaleza (1)	Costa Rica / Panama (1)
Spain (1)	Universidad Politécnica de Valencia (1)	Ecuador (1)
Total (78)	35	9

Barranquilla: Universidad de la Costa Barranquilla; **CICY:** Centro de Investigaciones Científicas de Yucatán; **IT-Mérida:** Instituto Tecnológico de Mérida; **UA-Chapingo:** Universidad Autónoma Chapingo; **IT-Chiná:** Instituto Tecnológico de Chiná; **ECOSUR-Cam:** El Colegio de la Frontera Sur, Campeche campus; **ITS-Calkiní:** Instituto Tecnológico Superior de Calkiní; **UA-NLeón:** Universidad Autónoma de Nuevo León; **PUCE:** Pontificia Universidad Católica del Ecuador; **NY:** New York; **CATIE-CR:** Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica campus; **UNCP:** Universidad Nacional del Centro de Perú; **UNIA:** Universidad Nacional Intercultural de la Amazonía; **UNA-Camoapa:** Universidad Nacional Agraria Camoapa.

In the case of Mexico, it was found that most institutions or research centers that have studied the *C. palmata* species are geographically located in the southeast of the country (eight out of eleven institutions). Additionally, in all cases, the study area

referenced has been the municipality of Calkiní in Campeche (Figure 4). Espinosa-Grande et al. (2023) found that for species with recent commercial value, it is common for new knowledge to be developed by institutions located within the region whe-

re the species is cultivated or naturally distributed. According to Santillán-Fernández et al. (2021), this facilitates the transfer of technology to agricultural producers.

4 Co-authorship network

In the 78 analyzed texts, 63 different first authors were identified. Including first authors and co-authors, the total number of unique individuals involved was 112. The author and co-author network (Figure 5) consisted of 112 nodes (authors) and 90 edges (connections). In co-authorship network analysis, connections are crucial because they enable an author to access ideas, knowledge, and information that would otherwise be socially distant to them (Granovetter, 1973). The main authors conducting research on *C. palmata* from 1961 to 2022 were: Galviz_Quesada_A (4 texts) from Universidad Nacional de Colombia, Medellín (UNC-Medellín), focusing on bio-

technology applied to species transformation processes; Zambrano_Arteaga_JC (3 texts, Fundación Universitaria Navarra), Chicaiza_Finley_D (3, UNC-Medellín), and Hoyos_Sanchez_RA (3, UNC-Medellín), mainly researching biotechnology applied to *in vitro* propagation of the species.

Another author in the network is Lopez_L (3 texts) from Universidad Politécnica Salesiana, Ecuador, who has also applied biotechnology to enhance the transformation of the species into commercially valuable products. Figure 5 further highlights a subnetwork composed of researchers from Mexico: Cordova_I (CICY), CetzalIx_W (IT-Chiná), Ortega_Hass_JJ (ECOSUR-Campeche), Godoy_Hernandez_G (CICY), Munoz_Sanchez_A (CICY), and Gonzalez_Estrada_T (CICY). Similar to their counterparts in Colombia and Ecuador, these researchers have applied biotechnological methodologies to revalorize the uses of the species.

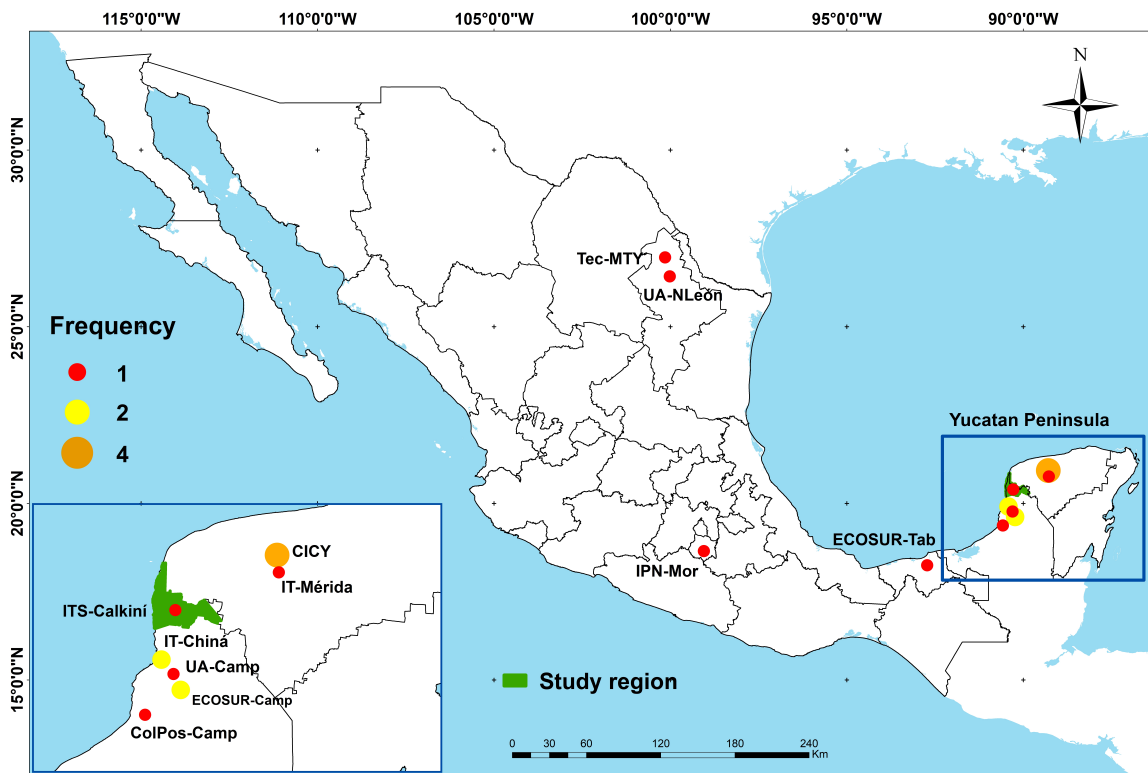


Figure 4. Spatial distribution of research institutions in Mexico that published scientific articles where the *C. palmata* species was studied from 1961 to 2022.

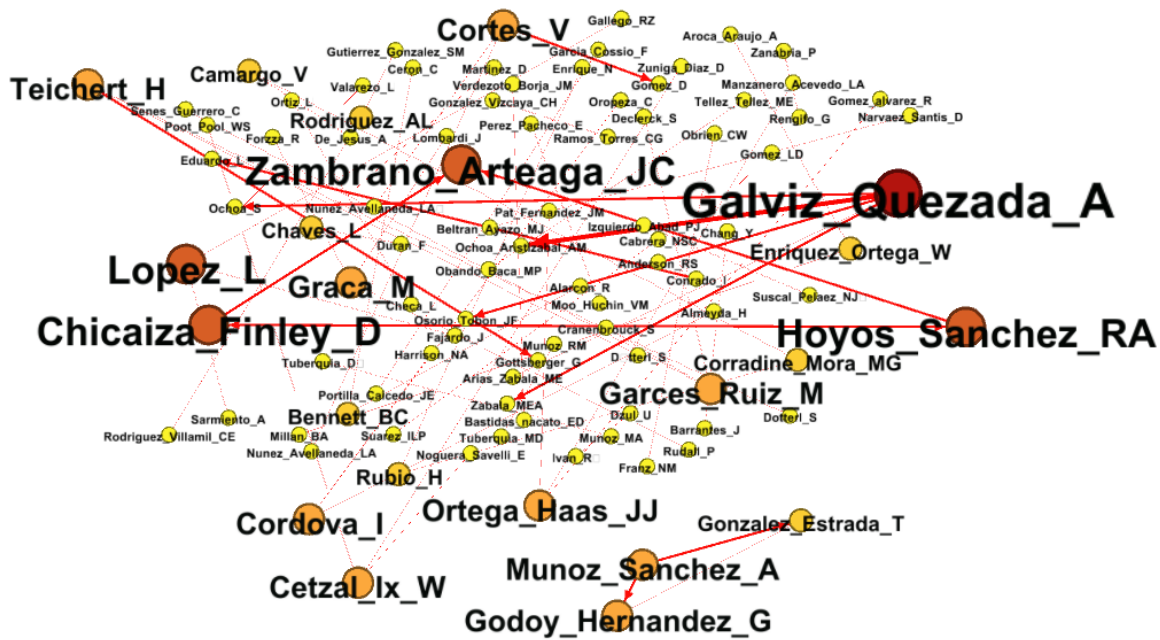


Figure 5. International network of authors and collaborators who conducted research on the *C. palmata* species from 1961 to 2022. The size of the node corresponds to productivity.

Santillán-Fernández et al. (2023) found that in Mexico's non-timber forest sector, biotechnology presents an opportunity—especially for species of recent commercial value. Most research has focused on describing the botany and uses of species, leaving knowledge gaps on how to improve the quality of raw materials (Espinosa-Grande et al., 2023).

The density of the co-authorship network was 0.002, revealing low collaboration between authors from different countries. Network density measures how well nodes (authors) interact with one another. It ranges from 0 to 1, where values closer to 1 indicate stronger interactions (Aguilar-Gallegos et al., 2016). However, in Colombia and Mexico, researchers from the same institution tend to collaborate among themselves.

According to Silva et al. (2014), this restricts constructive criticism and limits feedback on research relevance. Institutional research groups often replicate the same methodologies in different study areas, which hinders innovation and increases redundancy in published research (Santillán-Fernández et al., 2023). Thus, creating synergies

with authors from other institutions could be a valuable strategy to improve both the quantity and quality of research on *C. palmata* at the national and international levels.

5 Conclusions

The spatio-temporal evolution of scientific production revealed an exponential increase in scholarly publications addressing *C. palmata* as a research topic between 1961 and 2022. This output was concentrated in American countries where the species occurs naturally: Colombia (38), Mexico (11), and Ecuador (8). The most recurrent research themes were species botany (20), transformation of its fibers into handicrafts (18), traditional production (*in situ* cultivation) (17), and commercialization of handicrafts (15).

However, the studies with the greatest impact (measured by the number of citations) were predominantly conducted by researchers from the United States and Canada. Although these investigations were carried out in Latin America, they were published in high-impact journals in English.

Consequently, research on *C. palmata* in Latin America still has substantial room for improvement through the publication of studies in English and in higher-impact journals. A research gap was identified regarding the management and propagation of the species in artificial environments (*in vitro*). Except for Colombia, no other country has published studies on this subject. In the case of Mexico, research on *C. palmata* was concentrated in the southeastern region and led by institutions such as CICY, IT-Chiná, and ECOSUR-Campeche. These research centers are geographically close to the natural distribution area of the species, which could be a key success factor in generating impactful new knowledge, as it facilitates technology transfer. This is particularly relevant considering that research on *C. palmata* is still in its early stages.

Additionally, it was found that authors from the same institution tend to collaborate mainly among themselves, which limits constructive criticism and reduces feedback on research relevance. Strengthening collaborations with authors from other institutions could be an effective strategy to enhance both the quantity and quality of research on the species.

Finally, bibliometric techniques proved to be a useful methodology for identifying areas of opportunity in the development of new knowledge on *C. palmata*. Nevertheless, the theoretical nature of the findings should be acknowledged, as they primarily contribute to broadening the state of the art. Therefore, future studies are encouraged to focus on the practical application of scientific findings to agricultural management of the crop and to the conservation of the species.

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Authors' contribution

L.A.P.H.: Data curation. A.S.F.: Conceptualization, Formal analysis, Methodology, Writing – review and editing. N.A.G.: Writing – original draft. J.C.A.M.: Supervision. T.A.G.E.: Supervision. J.H.C.V.: Project administration.

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