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AN ANALYSIS

OF THE SCIENTIFIC PRODUCTION OF THE UNIVERSITY OF CIENFUEGOS IN SCOPUS IN THE PERIOD 2011 – 2020

ANÁLISIS DE LA PRODUCCIÓN CIENTÍFICA DE LA UNIVERSIDAD DE CIENFUEGOS EN LA BASE DE DATOS SCOPUS EN EL PERÍODO 2011 - 2020

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ABSTRACT

The analysis of scientometric indicators allows measuring the academic and research activity performance of universities. To date, there are no scientific works that explain the use of metric analysis to study the collections of articles of Carlos Rafael Rodríguez University of Cienfuegos (UCf) that are stored in databases of indexed journals. This article aims to describe the behavior of the scientific production of the UCf in the Scopus database for the period 2011-2020. A descriptive bibliometric study was conducted in order to measure the scientific production taking into consideration the following indicators: production, impact, collaboration, positioning, and their relationship with the Sustainable Development Goals (SDGs). It was concluded that the university still has a long way to go in terms of scientific productivity in spite of the growth seen in recent years, the number of articles produced is still insufficient and their impact is relatively low compared to the articles of other renown universities in the country. The relationship between the SDGs and the scientific publications of the UCf is not high and new connections are being established with SDGs 4, 9 and 7 that promote the development of education, industry and clean energy. Similarly, a link was detected between these and the increase in citations. As a final point, it can be asserted that the Revista Universidad y Sociedad (University and Society Scientific Journal) has directly influenced the behavior of scientific production of this university.

Keywords: Bibliometrics, scientific production, University of Cienfuegos, Scopus, Sustainable Development Goals

RESUMEN

El análisis de la actividad académica e investigativa de las universidades, basado en indicadores cienciométricos permite medir el desempeño de las mismas. Hasta el momento, no existe literatura que trate sobre análisis métricos de la colección de artículos de la Universidad de Cienfuegos "Carlos Rafael Rodríguez" (UCf) en bases de datos de revistas indizadas. Este artículo se propone describir el comportamiento de la producción científica de la UCf en la base de datos Scopus entre los años 2011 y 2020. En ese sentido se realizó un estudio bibliométrico de carácter descriptivo donde se aplicaron varios indicadores para medir la producción científica a través de indicadores de producción, impacto, colaboración, posicionamiento así como su relación con los Objetivos de Desarrollo Sostenible (ODS). Se pudo concluir que, la universidad tiene todavía mucho por avanzar en el tema de productividad científica pese al crecimiento experimentado en los últimos años, ya que aún cuenta con pocos artículos y el impacto de los mismos es relativamente bajo en comparación con otras universidades representativas del país. La relación entre los ODS y la publicación científica de la UCf no es alta y se establecen conexiones con los ODS 4, 9 y 7 que abogan por el desarrollo de la educación, la industria y la energía no contaminante. De igual forma se detectó un vínculo entre estos y el aumento de las citas. Por último, se puede afirmar que la Revista Universidad y Sociedad ha influido directamente en el comportamiento de la producción científica de esta universidad.

Palabras claves: Bibliometría, producción científica, Universidad de Cienfuegos, Scopus, Objetivos de Desarrollo Sostenible

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INTRODUCTION

Carlos Rafael Rodríguez University of Cienfuegos (UCf) is a higher education institution of the province of Cienfuegos, a territory in south-central Cuba. Founded more than 40 years ago, its origins date back to 1969 when teachers and students of the region started benefitting from training and improvement opportunities offered by the institution; over time, this resulted in an uninterrupted process of development of higher education in Cienfuegos. In pursuance of the University Reform (UR) of 1962, which promoted the development of higher education and scientific research as well as the restructuring of Cuban universities, the Branch Campus of Cienfuegos was established in 1972 as an affiliate of Marta Abreu Central University of Las Villas (UCLV) (Leyva & García, 2018). In 1976, Cuba embarked on the transformation its territories following approval of the new political-administrative division; the region of Cienfuegos became one of the 14 Cuban provinces at that time. This process, along with the industrial growth and increasing need to train professionals for the blooming province, led to the creation of the Higher Technical Institute of Cienfuegos in 1979 and its first two faculties: Economics and Engineering. The creation of this institute marks the official date of the foundation of the university.

During the same period as the creation of the UCF, several provincial universities were founded in the country, such as the University of Camagüey (UC) (the first university of the Cuban revolutionary era), the University of Ciego de Avila (UNICA), the University of Granma (UDG) and the University of Matanzas (UM). All of them were founded with the objective of establishing agents of economic and social development, ensured by the continuous training of professionals, with a strong disposition to launch degree courses linked to the agricultural and industrial sector.

The University of Cienfuegos, like most higher education centers consolidated in the 1970s in Cuba, had as basis the branch campuses created and developed under the University Reform. Special relevance is given to the relationships of the newly-created universities with the considered "parent universities"—those that had been established years ago in the former territories such as the University of Havana (UH), first in the country and with more than 300 years of foundation; the University of Oriente (UO), second center of Higher Education created in 1947; and the University of Las Villas (UCLV), founded in 1952, with which the UCf has the closest links.

The UCf has undergone a continuous process of development and transformation of its degree courses, its scopes and its research objectives. In the 90's, the university implemented changes by incorporating non-technical degree courses; this resulted in the creation of the faculties of Social Sciences and the Faculty of Humanities in 2000. The faculty of Computing was created this same year in keeping with the university's technical tradition. Influenced by the Universalization of Higher Education, eight university campuses were created in each municipality of Cienfuegos province and new degree courses of different fields were opened, with greater emphasis on the courses in humanities, economics, and agricultural and livestock. The university is currently made up of seven faculties: the Faculty of Social Sciences, the Faculty of Physical Education, the Faculty of Engineering, the Faculty of Humanities, the Faculty of Agricultural Sciences, the Faculty of Education, and Faculty of Economics and Business Studies, in addition to several affiliated Study Centers that conduct research on energy, environment, agricultural transformation, didactics and socio-cultural studies.

It is the only institution of its kind in the province; this acquires special importance for the territory for it contributes to its socioeconomic development, outlining its main lines of research in response to the economic and social needs of the region. Cienfuegos sustains its economy on industrial development and to a lesser extent on agriculture (García, 2021). For this reason, local development, energy, technology, environment and sustainable agricultural transformation are the main university's avenues for research, conducted by its Study Centers and with the endorsement the provincial government in order to ensure the integral growth of the province.

The other higher education institution in the region is the University of Medical Sciences of Cienfuegos (UCMCFG), officially declared university in 2009; nevertheless, the greatest generation of scientific production rests in the hands of the UCf for its more than 40 years of history.

Scientific production is the essence of universities (Piedra & Martínez, 2007). It is defined as the evidence of the scientific knowledge generated, it makes research visible, it reflects the academic and scientific activity of a researcher expressed in publications that involve an institution or social group, which contributes to the development of knowledge and the improvement in the quality of life of the inhabitants of a country. (Livia et al., 2022).

On the other hand, bibliometric studies allow the analysis of scientific production and are based on the application of statistical analysis to evaluate the characteristics of the use and creation of documents, their producers and consumers, so as to observe the state of science and

technology, through the global production of scientific literature at a given level of specialization (Solano et al., 2009).

One of the most important sources of information currently used for bibliometric analysis is the bibliographic database Scopus® (https://www.scopus.com) (Elsevier, The Netherlands). It is a multidisciplinary database with extensive coverage of bibliographic references and abstracts of peer-reviewed scientific articles (Burnham, 2006). It also indexes more than 40,000 journals (of which more than 27,000 are active) that address topics from various disciplines such as science, technology, medicine, social sciences, arts and humanities. Scopus includes intelligent tools to manage, analyze and visualize research data, as well as the behavior of institutions (Falagas et al., 2008). The UCf is one of the 101 Cuban institutions with presence in the Scopus database. According to the volume of publications, it is ranked 24th of all national affiliations and 9th among the 13 universities that currently have profiles in this database.

Even though the 40 years of scientific activity of the UCF in Scopus is a noticeable fact, it was initially insufficient scientific production to achieve a correct impact analysis over time (Fernández et al., 2018); however, with the recent increase in the university's publications, especially in recent years, better opportunities for this purpose have arisen, as demonstrated by the study by Hidalgo & Mirabal (2022), which however, presents only a partial analysis of the university's scientific production by considering only the presentations of the UCF at a scientific event on university teaching. Therefore, there has been a genuinely long-standing need for an analysis that provides a general overview of the scientific status of the university, that will in turn allow to evaluate (and if necessary, restructure) the research policies, thus enhancing the growth of the institution at the scientific level. In this context, this article puts forth a bibliometric analysis of the scientific production of the UCF in the Scopus database for the last 10 years.

MATERIALS AND METHODS

File location

The analysis focused on the period 2011 – 2020, using the institutional profile of the University of Cienfuegos, identified in Scopus with Afilation ID 1: 60070378 and includes the following profiles: University de Cienfuegos, Universidad De Cienfuegos "carlos Rafael Rodríguez", University Of Cienfuegos, Universidad De Cienfuegos Carlos Rafael Rodríguez, Universidad de Cienfuegos "carlos Rafael Rodríguez, Universidad de Cienfuegos (UCf). To avoid bias introduced by affiliation errors, searches were performed using the terms Cienfuegos University, Universidad de Cienfuegos, Universidad de Cienfuegos UCf, Universidad de Cienfuegos Carlos Rafael Rodríguez", "University Carlos Rafael Rodríguez", "University Carlos Rafael Rodríguez of Cienfuegos", "Universidad Carlos Rafael Rodríguez. Cuatro Caminos", "Bioquímica Universidad Carlos Rafael Rodríguez". Eighteen articles were found that required actions for their incorporation in the file of the UCF in Scopus. The latter were not considered in the present study.

Data processing

The data obtained were exported in CSV format prioritizing the collection of metadata with bibliographic information, citation information and keywords of the set of articles. These data were standardized and processed using VantagePoint software https://www.thevantagepoint.com, a tool that allows managing large volumes of data and performing patent analysis, technology planning, decision making, data cleaning, conversion and reuse.

SciVal https://www.scival.com/landing (Elsevier, The Netherlands) was also used to perform more complex analyses of the retrieved data. This tool, developed by Elsevier's Research and Intelligence Group, allows the analysis of large volumes of research performance data from research institutions and their associated researchers, as well as from journals indexed in the Scopus database.

For the visual analysis of the information, generation of graphs, tables, structural networks and co-occurrence maps, the software Microsoft Excel https://www.microsoft.com/es-es/microsoft-365/excel, SCImago Graphica https://www.graphica.app/ and VOSViewer https://www.vosviewew.com were used, tools that allow the analysis, visualization and sharing of large volumes of information by means of the elaboration of graphs and tables. VOSViewer also allows the construction and visualization of bibliometric networks.

Indicators Considered

Production

- Number of documents (Ndoc): Number of UCf documents.
- Citable documents (DocCit): Documents that can be cited. Original Articles, Review Articles and Conference Articles.

Impact

- Citations per year: Number of citations received per year.

- Citations per publication (Cp): Average number of citations received per paper.

- Self-citations (Aut): Citations that authors or journals make to their own publications.

- Institutional self-citation (ISC): Total self-citations of an institution in a given period.

- Institutional self-citation rate (ISCR): Total number of ISCs divided by the total number of citations received by an institution's researchers. It is calculated as follows: 100 [ISCR = (ISC / total citations received)x100]

- Source-Normalized Impact per Paper (SNIP): is a measurement factor based on the comparison of publications within their subject fields, keeping count of the frequency with which authors cite other papers and the immediacy of the citation impact.

- CiteScore: Indicator of research impact and influence. It is calculated on the basis of the number of citations a journal receives in one year of documents published in the three preceding years, divided by the number of documents indexed in Scopus published in those same three years.

- SJR: This is a factor for measuring the impact of journals that establishes the quality of scientific publications based on the average number of weighted citations received in the selected year, by the documents published in the selected journal in the three previous years.

- Field-weighted citation impact (FWCI): ratio between the total number of citations received and the total number of expected citations based on the average of the subject field. FWCI = 1: the result is as expected for the average. FWCI > 1: the result is higher than expected. FWCI < 1: the result is lower than expected.

- Quartile distribution (Q1, Q2, Q3, Q4) refers to citable papers indexed in journals occupying these quartile positions. Based on the SJR value, journals occupy a position from the division of their categories. This distribution determines the degree of visibility of the journals belonging to each quartile; the highest visibility is found in the first quartile, and it will decrease as it goes further down in position.

Collaboration

- International Collaboration (Icol): Production published in collaboration with institutions outside the country studied.

- National Collaboration (Ncol): Production published in collaboration with institutions belonging to the country studied.

- Institutional Collaboration (Inscol): Production published without collaboration with other institutions.

Thematic indicators.

- Keyword analysis: The topics covered in the documents of the university in Scopus can be identified through keyword analysis (Wang & Chai, 2020). Precisely, this database presents 2 metadata related to these, the keywords entered by the authors (Author Keywords) and the indexing keywords (Index Keywords).

- Sankey Diagram: Flow diagram showing the relationship between these and their quantities within any process. The thickness of the lines is used to show their magnitudes, the greater the width, the greater the amount of flow. Arrows or flow lines can be combined or divided across their paths at each stage of a process. Color can be used to divide the diagram into different categories or to show the transition from one process stage to another (Riehmann et. al, 2005).

Positioning Indicators.

- SCImago Institutions Rankings (SIR) https://www.scimagoir.com: provides a ranking of research-related institutions by evaluating indicators.

- QS World University Rankings (QS) https://qs.com: world ranking of universities based on academic performance, research and its impact, usability and internationalization.

- Ranking Web of Universities (RWU) https://www.webometrics.info: ranking of higher education institutions linked to the visibility and activity of universities, based on impact, quality of content, international prestige, academic performance, total presence of pages hosted in the main web domain, among other indicators.

RESULTS AND DISCUSSION

In the Cuban context, scientific policies are defined in correspondence with the country's development priorities, which are expressed in the directives of the governing institutions. The Ministry of Science, Technology and Environment (CITMA) is the institution in charge of directing this activity; the Ministry of Higher Education (MES) follows the policies outlined by the aforementioned ministry to establishes its own at the ministerial level, which is in turn contextualized in each university according to territory-specific demands and the relations between local institutions and other territories. This contextualization compels the UCf to formulate policies of science, technology and innovation based on scientific research, human capital training, dissemination of results, and evaluation, control and monitoring of the impact of research (Fernández et al., 2018). These policies have been adjusted over time with the growth of the university, emphasis

was placed on the creation of new faculties of the social and humanistic fields, which had posed a long-standing institutional challenge.

The changes in research policies, in addition to the creation of several research centers affiliated to the university, as well as the consolidation of municipal branch campuses instituted in previous years, had a direct impact on the results of scientific research carried out at the university. The effects of their implementation and compliance have an impact on the growth of the UCf's scientific production, a phenomenon that is further enhanced by the decision of the MES to prioritize scientific, technological research (R&D) and doctoral training (Fernandez et al., 2018).

Production

The volume of the UCf's scientific production amounted to 281 articles between 2011 and 2020, with an average publication rate of 28 papers per year. The general behavior of the production can be described as proceeding almost invariably, with a slight tendency to increase but with similar values throughout the period analyzed until 2019, year in which a considerable growth in its indicators can be seen. This trend was maintained in the subsequent year, as shown in (Figure 1), highlighting 2020 as the year with the highest number of documents accrued by the university, for a total of 112 articles. Compared to the previous years, the latter alone represents the 40% of all publications, which is a noticeable high result. This fact is reflected in the individual analysis by quartiles where the results reveal that the values for Q1, Q2, and Q4 are affected after 2019 (see Figure 1), after maintaining a relative stability in the previous years. This rise is more defined in the case of the last quartile with a substantial increase for the year 2019, and triple the production for the year 2020, all of which had a direct impact on the overall behavior. As for the data referring to Q3, they experienced a decrease in 2019, with production dropping to only 1 document in that year, and then registering a record growth of its values in the last year studied.
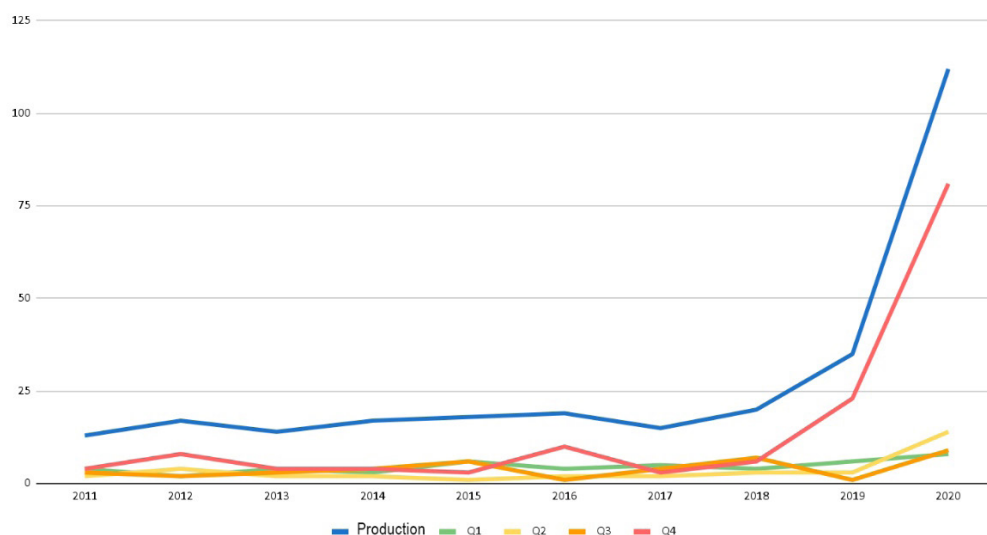

Figure 1: Scientific production tendencies of the UCF shown in quartiles and years. Software used: Excel.

The documents within the Q1 in the UCf represented 16.4% of the total volume. According to the results found, the highest percentage was reached by articles located in Q4 with 52.1%, which leads to conclude that most of the institution's indexed articles presented low-impact levels. In other words: more than half of the total production of the UCf, published between 2010 and 2020, was disseminated in journals of low effect and impact within their respective fields.

The relationship with the positioning in certain quartiles and the visibility and impact of the publications affected the papers analyzed. As shown in (Figure 2), the papers located within the first quartile are those with the highest visibility and weighted impact (FWCI[1]) The graph below shows a high number of citations for Q1 papers which include more than 780

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[1] Field Weighted Citation Impact (FWCI): is an author metric which compares the total citations actually received by a researcher's publications to the average number of citations received by all other similar publications from the same research field.

citations, representing the 62.9% of the total. The rest of the quartiles as a whole accumulated 32.7%. Fewer citations can be seen in Q3. In the upper right part of the figure we can see a data which, apart from being relevant, corroborates the above: the FWCI. This impact indicator performs a weighting of citations according to the field addressed, and in the case of the results of the UCf publications located in Q1 it reaches a value of 1.03. A value higher than 1.00 indicates that the publications have been cited more than expected, in other words, the documents in Q1 were cited 0.3% more than expected.
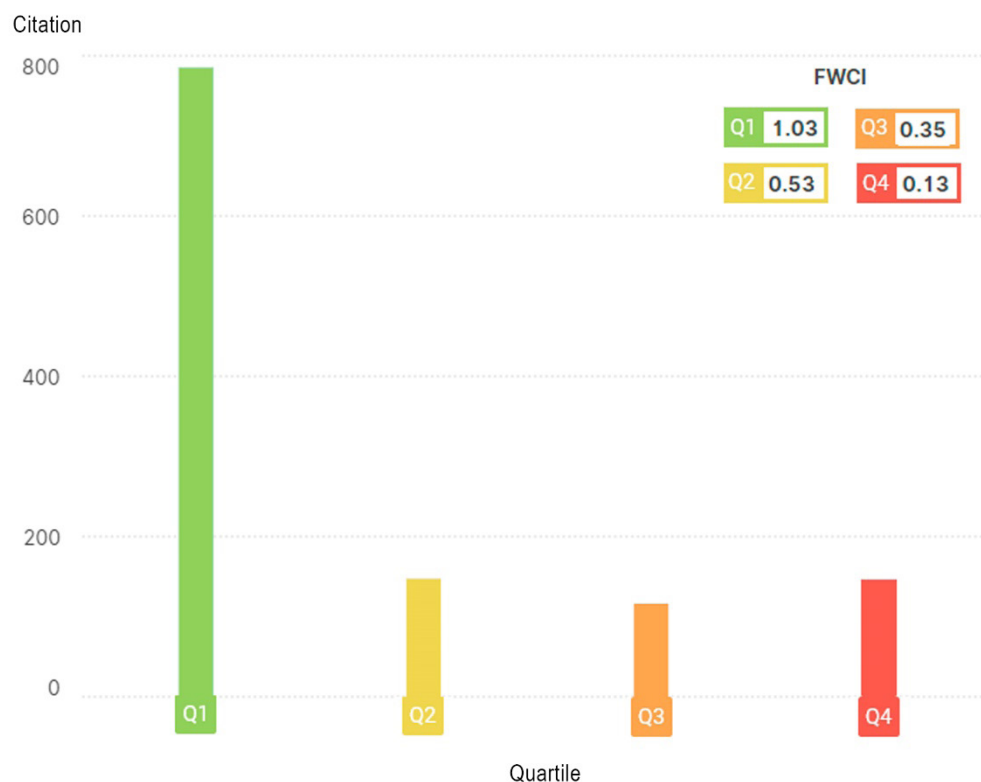

Figure 2: Behavior of citations received by the UCf distributed by quartiles and Weighted Citation Impact. Software used: SCImago Graphica.

Having analyzed the levels of citations per year and the correlation of the self-citations made, a variability of citation values can be seen in addition to low levels of self-citation in the period. As evidenced in (Figure 3), the citation peaks suffered a decrease between the years 2011 and 2014; however, a significant increase in numbers is palpable for the year 2018, with the highest number of citations received during the period studied. The total self-citations amounted to 157, the records show a behavior similar to that described above, but with an increment in the year 2016 that maintained a stable trend in the following years. Another analysis derived from this graph is that of the ISCR represented by (12.4%). A high percentage in this indicator may suggest the presence of "invisible colleges" of scientists within the university, indicative of bad practices of researchers to deliberately increase the impact of personal and institutional indexes (Hedrix, 2009). In the case of UCf this indicator behaved in a non-significant way, and although self-citations are generally associated with negative trends they can also respond to a possible continuity of research work.
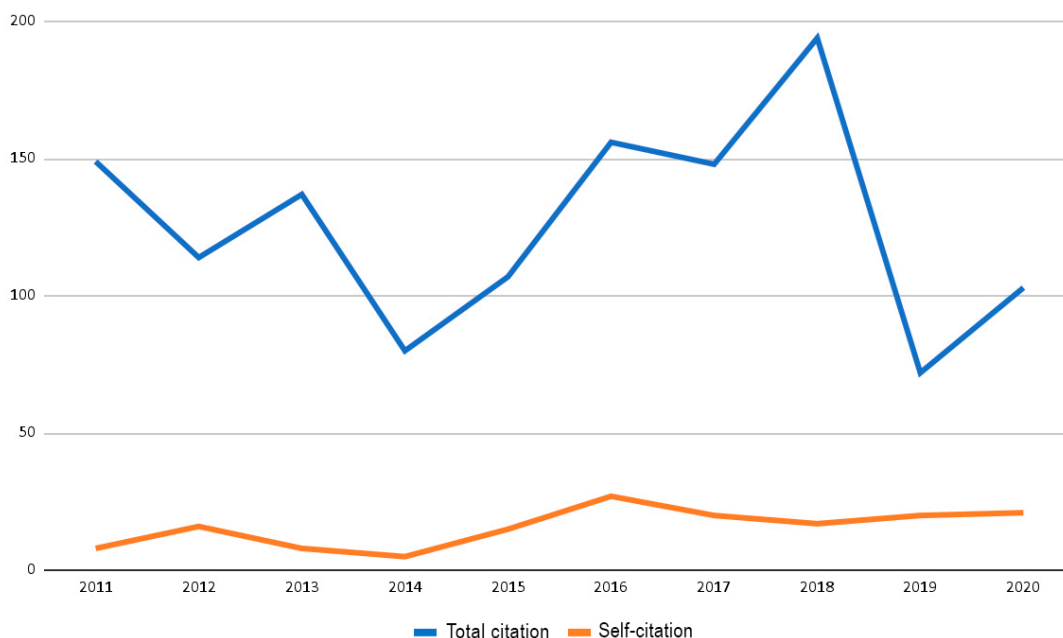
Figure 3: Self-citations with respect to total citations distributed by year. Software used: Excel.

Figure 4 shows the level of impact obtained by the institution's production distributed according to the typology of the documents. The dispersion by quartile indicates a high degree of publication of original articles, with Q2 having the highest concentration of conference papers and Q3 the highest concentration of reviews.
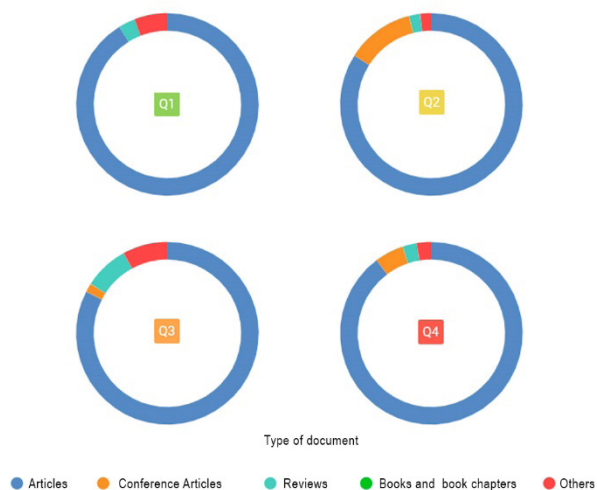
Figure 4: Production and Impact by type of document[2]. Software used: SCImago Graphica.

Original articles are the document type most used by researchers at the University of Cienfuegos; because of their characteristics, they are also the document type that received the most citations. Table 1 shows the relation between document typology, impact, and language of publication. In this case, a gradual increase in original articles was observed over the years, along with as increase in the number of original publications written in English and their impact.

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[2] Others: Editorials, Letters, Errata, Notes y Data paper

Spanish is the language most frequently used in the documents analyzed, with 54% of the total, followed by English (48.3%). However, in terms of citations received, the behavior was different. Articles published in English, or with multiple language versions but containing English as one of the languages, received 87.3% of the total number of citations. On the other hand, documents in Spanish received only 15% of the citations. Citations are an indicator that reflects the impact achieved by a certain publication. This data shows that documents positioned in English achieve a higher level of impact and visibility, representing the 87% of the world volume[3].

Table 1: Production and impact by language of publication.

Document Type/ Language	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	Citations
Articles	11	14	11	14	17	15	13	16	29	94	234	1142
English	6	4	8	8	8	6	9	8	13	23	93	986
English and Portuguese				1							1	10
English and Spanish	2	2	2	1		3				1	11	30
Portuguese				2	1			1			4	2
Spanish	3	8	1	2	8	6	4	7	16	70	125	126
Books and Book Chapters		1		1							2	2
English		1		1							2	2
Conference Articles	1	1	2	2		3	1	2	2	5	19	53
English	1	1	2	2		3	1	2	1	5	18	52
Spanish									1		1	1
Others1	1		1		1		1	2	2	10	18	7
English			1		1		1	1		3	7	5
English and Spanish										1	1	
Spanish	1							1	2	6	10	2
Reviews		1				1		1	2	3	8	44
English		1								3	4	15
Spanish						1		1	2		4	29
Total	13	17	14	17	18	19	15	21	35	112	281	1260

Collaboration

For a university, collaboration in its scientific production represents an important indicator of success in the processes linked to the scientific dissemination of research results. This is why the link between actors outside the institution contributes to increasing production levels and international visibility, especially for developing countries (Rørstad, 2021). Beyond analyzing collaborative processes from a bibliometric point of view, Rørstad (2021) identifies that collaboration "allows greater productivity and quality of research".

This is why an analysis of the levels of collaboration of the UCf was carried out, where 117 institutions were found, 49 from the South American region with 48% of the collaboration, 41 from North America for a 32%, 23 from Europe with 18% and finally 3 from Asia, which added to one from the African continent represent the remaining 1% of the collaboration (Annex 1). The largest number of institutions linked to the scientific articles of the university studied belong to Mexico with 16, followed by 15 institutions from Spain and 13 Cuban entities. Another relevant aspect that should

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[3] Data confirmed on 20/04/2022 in SCOPUS for 86 million documents.

be added to the previous analysis is that Colombia is the country with the highest number of collaborations, 65 in total, with the UCF, which is more than the 53 collaborations with other Cuban institutions with which they are linked for publications.

Table 2 lists the institutions that cooperate most with the UCf. This provides indicators associated with the productivity and impact achieved through these collaborations. The first place in terms of production levels went to the Universidad de la Costa, a Colombian academic institution that collaborated in 34 articles with the University of Cienfuegos. However, the papers from the Katholieke Universiteit Leuven had the greatest impact, receiving 417 citations. In the Cuban arena, the University of Cienfuegos had the highest number of publications with the university of Las Villas, with 21 joint efforts and 113 total citations. Despite the fact that the greatest collaboration is with Colombia, it is the European collaboration that had the greatest impact for the UCf.

Table 2: Top 10 institutions that collaborate with the UCf

Institution	Sector	Country	Ndoc	Citations	Cp	FWCI
Universidad de la Costa	Academic	Colombia	34	334	9,8	0,97
Universidad "Marta Abreu" de Las Villas	Academic	Cuba	21	113	5,4	0,47
Katholieke Universiteit Leuven	Academic	Belgium	18	417	23,2	1,26
Universidad de Granada	Academic	Spain	15	56	3,7	0,46
Universidad Autónoma de Occidente	Academic	Colombia	12	97	8,1	0,89
Flemish Institute for Technological Research	Academic	Belgium	10	263	26,3	1,37
Universidad de Matanzas	Academic	Cuba	10	28	2,8	0,37
Universidad de Guayaquil	Academic	Ecuador	9	3	0,3	0,07
Universidad Simón Bolívar	Academic	Colombia	8	11	1,4	0,23
Universidade Estadual Paulista Júlio de Mesquita Filho	Academic	Brazil	8	27	3,4	0,37

Another important aspect linked to collaboration is the analysis of the behavior of authorship of the scientific production of the UCF. A total of 1142 authors were found, of which 506 are from the UCf. Figure 5 below shows the ratio of articles authored by UCf researchers and the number of citations received by these authors. The first analysis drawn from this correlation is that the more collaborations between these authors, the fewer citations they received; on the contrary, articles with foreign authors exponentially increased the number of citations. In the figure, 2 large citation peaks are visible, accompanied by low values in the percentages of presence of authors from the institution. A second analysis is determined by the periods evaluated. A higher density is noted in the left zone of the graph, which corresponds to the first years studied. The decrease in citations in the most recent years is largely due to the fact that the articles take between 1 and 3 years to reach the "maturity" of their scope, depending on the subject matter and type of article.
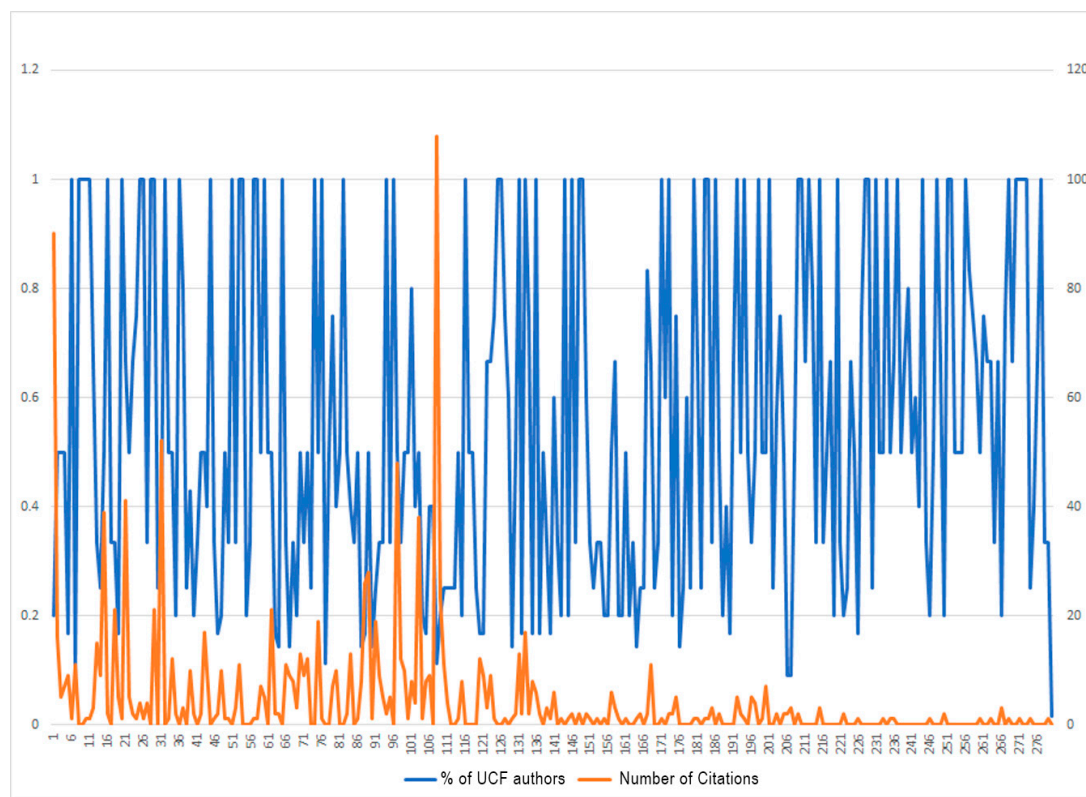
Figure 5. Number of citations according to institutional authors. Software used: Excel

The collaborative links from a broader perspective, detailed in (Table 3) below, support the previous results obtained from different perceptions. Overall, greater values are obtained in connection with the number of articles in international collaboration (Icol) with 169 (60.4%), engrossing 88% of the total number of citations. These data, obtained through the use of SciVal, also include other types of collaboration and show a clear difference in impact levels according to them. National collaborations (Ncol) amounted to 49 (17%), with 6% of the total citations; institutional collaborations (Inscol) offered 36 manuscripts (13%); ultimately, single authors were identified with 26 documents, (9%) of the total number of documents. It can also be observed that the average number of citations per document is higher when published in collaboration with international authors, the complete opposite effect is observed for collaborations in single authorship. On the other hand, research in which collaboration with the business sector took place accounted for only 0.7%, evidencing the narrow research bond between the university and the business sector. Despite this, the average number of citations per article behaved similarly to the collaboration between the university and academic centers. The remaining 99.3% were collaborations between higher education institutions as mentioned above, which reached the 1214 citations, so that in the case of the UCf the collaborations with this type of centers produced a higher number citations.

Table 3: Types of collaboration according to data obtained from Scopus. Software used: SCImago Graphica

Colaboración	%	Ndoc	Citations	Cp
Icol	60,4	169	1080	6,4
Ncol	17,5	49	71	1,4
Inscol	12,9	36	52	1,4
Single author	9,3	26	21	0,8
Academic - Corporate	0.7%	2	10	5
Academic	99.3%	278	1214	4,4

A total of 122 journals and 11 congress minutes were found in which UCf articles were published (Annex 2). In the case of journals, the largest number are located in the fourth quartile with 36 (29.5%). In the case of scientific publications in Q1 and Q2 there were 24 (19.6%) in each case and in Q3 27 (22.1%), these percentages were obtained from the total number of sources found. Table 4 shows the top 10 journals where articles from the academic institution of Cienfuegos were published, as well as several indicators regarding production, impact and collaboration.

Table 4: *Top 10 journals where the UCf has the higher number of publications, 2011-2020*

Journas	Ndoc	Quartil (2020)	Citations	Cp	Icol	Ncol	Inscol	Single author	Several Authors	Language
Universidad y Sociedad	69	Q4	21	14	26	22	12	9	224	Spanish
Revista Cubana de Medicina Militar	12	Q4	12	7	8	1	2	1	19	Spanish
Journal of Cleaner Production	9	Q1	343	9	9	0	0	0	19	English
Lecture Notes in Computer Science	7	Q2	35	6	7	0	0	0	10	English
MEDICC Review	6	Q3	25	5	2	1	1	2	12	English
Ingeniare	6	Q3	19	2	3	1	1	1	9	English
Revista Cubana de Educación Médica Superior	6	Q3	5	4	1	2	3	0	13	Spanish
International Journal of Electrical and Computer Engineering	4	Q2	24	4	4	0	0	0	10	English
Ingeniería e Investigación	4	Q4	20	4	1	1	2	0	11	English; Spanish
International Journal of Energy Economics and Policy	4	Q1	13	4	4	0	0	0	7	English

This group of journals is responsible for disseminating 70% of the articles and receiving 40% of the general citations, the latter associated with publications in English. In fact, the journal that reported the highest number of citations was the Journal of Cleaner Production positioned in Q1 which publishes in English.

Revista Universidad y Sociedad (RUS) is at the top of the list with regard to the number of manuscripts, accounting for the 24.5% of all the documents published in the period studied with 69 articles. It is gathered the largest number of authors with 224, a significantly high number compared to the rest of the sources. As for collaboration, it also presented higher values than the rest. These are expected results given the fact that RUS is the official publication for scientific dissemination of the University of Cienfuegos.

As a relevant fact, it should be mentioned that this journal was indexed in the year 2020 in Scopus, thus assuming a leading role in the dissemination of scientific results of the university. It is no coincidence that many of the analyses performed so far reflect drastic increases in indicators, especially in the year 2020, the same period in which the RUS begins to become visible. First of all, a growth of articles in Q4 was noted in recent years, articles in Spanish increased during that period, consequently increasing the institutional collaboration. This behavior of the UCf's scientific production undoubtedly bears a direct connection with RUS.

In an analysis of the topics from a productivity-oriented perspective, the following Sankey Diagram (Figure 6) shows the evolution of the documentary flows of the UCf's scientific communication, according to the Scopus disciplines. The left area groups the years analyzed, represented in descending order according to the number of documents. The right area shows the disciplines, organized in the same way. We can observe that in the first years, the behavior of engineering publications was higher than the rest of the disciplines. This behavior was maintained until 2020, when, with a high concentration of documents, the Social Sciences and the Economic and Business Sciences stood out as the most studied. This is supported by the high co-occurrence of keywords related to these disciplines, which were grouped in the main relational clusters (Annex 3). The impact of the growth in the publication of articles dealing with the aforementioned topics is unquestionable. Despite this phenomenon occurring in the final year, they were the most studied in the entire period. The Social Sciences represented 37.3% of the total number of articles, followed by documents dealing

with business and accounting topics with 30.60% and economics with 28.11% respectively. Similarly, engineering, the prevailing topic until 2019, reached the 21.3%. Other subjects analyzed are related to the study of the environment and energy, which receive special attention from the university. Nevertheless, the values of these disciplines turned out to be low in terms of production volume.

This phenomenon matches temporally with the indexing of RUS in Scopus. The use of this database as a source allowed to confirm that most of the journal's topics are grouped into Social Sciences and Business, Management and Accounting. This shows that the social angle of most of its publications directly influenced the total volume status of the entity and the topics most addressed within its scientific production. Once again, the impact of RUS on the UCf's research activity is revealed.
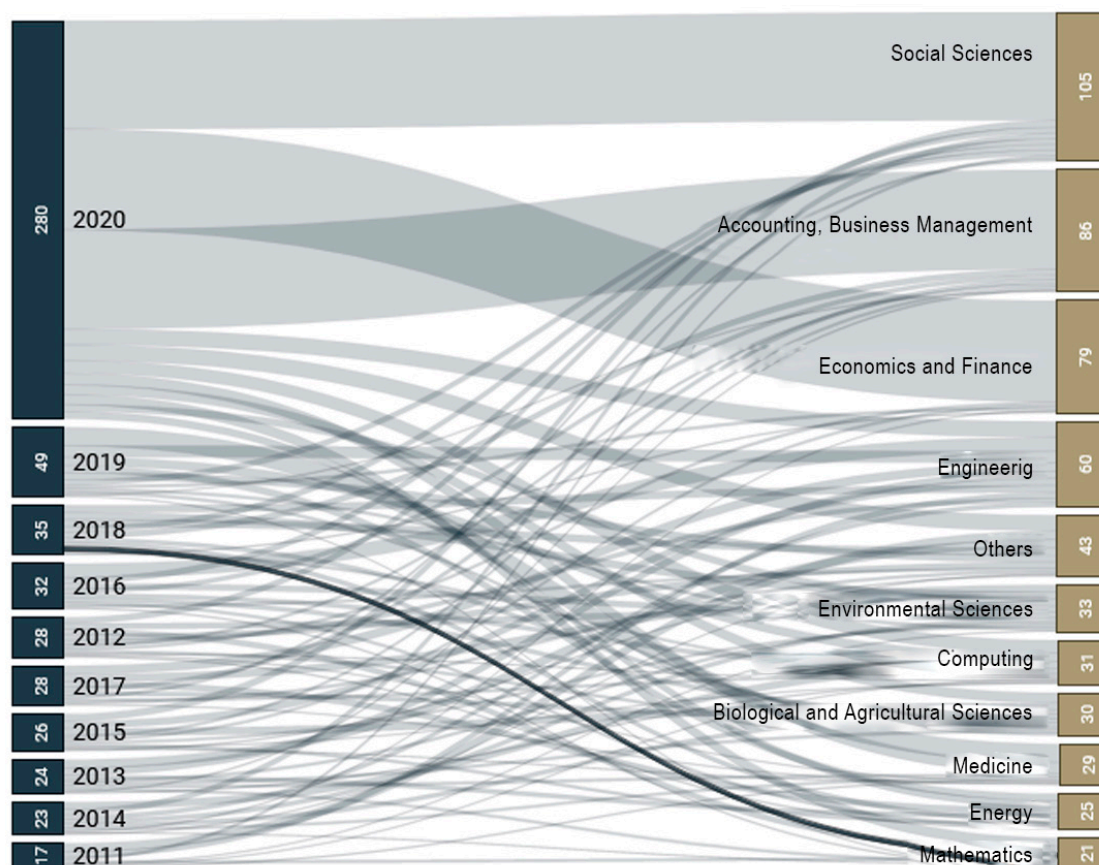

Figure 6. Behavior of the number of articles by field according to Scopus. Software used: SCImago Graphica

Indicators related to the scientific production of an institution or a country in a given period have become a key point in scientometric studies (Bornmann et al., 2020). On the other hand, González, et al. (2011) state that the analysis of scientific activity in academic institutions of higher education is a crucial factor in measuring their performance. The interconnection between these factors has prompted the establishment of university rankings, most of which base their classifications on outcome indicators such as publications (Bornmann et al., 2020).

Generally speaking, these rankings, despite the criticism they have received, are accepted as ways of evaluating and classifying higher education institutions based on the analysis and weighting of bibliometric indicators for the most part (Martínez, 2022). These indicators, according to King, et al. (2020) allow comparing the quality of academic and research activity of these institutions.

These international rankings bear a direct connection with the concentration of large amounts of resources, thus the general assumption is that better results will be obtained if more resources are made available. In a study of U.S. and

European models, Lepori et al. (2019) demonstrate this close relationship between university income and publication and citation volumes. This has implications for assessment practices, academic management and public policies.

Based on the criteria of positioning in specialized sites that rank of university institutions such as SIR, QS and RWU, (Table 5) below shows a comparison of the UCf with the main Cuban universities with presence in Scopus. These universities are the UH, the UCLV, the University of Medical Sciences of Havana (UCMH) and the UO.

Table 5: Comparison of universities according to production volume per year4

University	Ndoc	Citations	QS/2023	SIR/2022	RWU
Universidad de La Habana	3518	27656	463	704	2211
Universidad Central "Marta Abreu" de las Villas	1455	13393	531	690	4606
Universidad de Ciencias Médicas de La Habana	1484	3190	-	700	-
Universidad de Oriente	752	4933	-	699	4087
Universidad de Cienfuegos	281	1260	-	684	5222

This table shows the values achieved by the scientific production of these centers taking into account several of the indicators used for their classification in the rankings, such as the volume of production and citations, as well as the positions achieved according to the rankings analyzed.

It is evident that UCf has no presence in the QS Rank. On the other hand, it is the best ranked university in the SIR, which makes it in the year 2022 as the one with the highest scientific research impact in Cuba according to this portal's data. With regard web ranking, it is ranked ninth in the nation, out of 33 institutions classified by this site. In general, the number of UCf documents and citations received in Scopus is lower compared to the rest of the universities.

The last analysis focuses on the interaction of the Sustainable Development Goals (SDGs) https://www.undp.org/es/sustainable-development-goals with the scientific production of the UCf oriented towards the fulfillment of the 2030 Agenda as a priority for Cuba. At the national level, besides the strong commitment made to achieve the agenda's objectives, a whole series of adjustments were made in the strategic planning of the government and its institutions. This is why the MES develops its indicators, goals and strategic objectives in line with the SDGs. In general, higher education, and especially universities, should contribute to all SDGs with their processes (Alonso-Becerra et al., 2021).

A total of 112 articles associated with the SDGs were reported (Annex 4), reaching a peak of interest in 2020 with 80 documents (71.4%). The SDGs most addressed were 4, 9 and 7 related mainly to education, industry and clean energy. These topics are strongly connected to the university's lines of research. Most of articles on Sustainable Development Goals were published in quartile 4, totaling 85 papers, although high representation was seen in the first quartile with 62 articles.
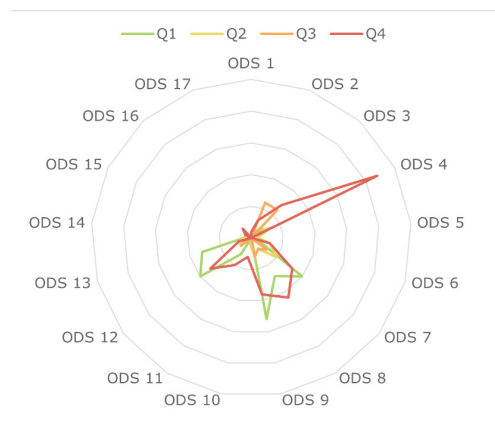

Figure 7. Number of articles with ODS distributed by quartile. Software used: Excel

4 Institutional ranking is based on the most recent positions (2022)

A connection was established between the articles positioned in the first quartile and SDGs 9 and 12 concerning industry and responsible consumption habits. As for the behavior in the last quartile, SDG 4: quality education, represented the majority.

Connection also existed between the number of SDGs addressed within one article and the number of citations received (Annex 4). The total average number of citations per article is 4.47, though lower average number of citations is appreciable for articles not related to the SDGs. On the other hand, an increase in citations is evident as these topics are gradually incorporated into research, this being the case of 2 articles that comply with 7 SDGs at the same time and averaged 60.5.

A similar behavior is experimented by countries that collaborate with the UCf (Annex 4). The greatest number of collaborations was concentrated in countries that address the SDGs in their articles, as is the case of Colombia mentioned above. In other words, the greater the number of documents related to the development goals, the greater the collaboration with the UCf.

CONCLUSIONS

The descriptive bibliometric analysis presented in this paper allows to conclude that much more remains to be done in terms of scientific productivity at the UCf. Social Sciences, followed by Business Sciences, Economics and Accounting were the fields that received the most attention. The university has insufficient articles in publications, being most of them original research papers written in Spanish and published mainly in quartile 4 journals. Articles published in English, on the contrary, received 87.3% of the institution's citations even though they only represent the 48.3% of the total.

The University of Cienfuegos has a relatively low production impact compared to the rest of the representative universities of the country. However, according to the institutional ranking of the SIR portal, it ranked first in Cuba based on the indicators of 2022. Regarding the rest of institutional and university rankings, the University of Cienfuegos either does not have representation or its positioning is very poor.

Regarding the levels of scientific collaboration, the international collaboration is the predominant type representing the 60% and is also the one of greatest impact. Colombia is the country with which most links were made. Belgium, on the other hand, has ensured the collaborations with the highest levels of citation. In the national arena, the UFC's most extensive ties are with the UCLV.

The journal with the highest number of published articles is the same official publication of scientific communication of the university. It is worth mentioning that the incorporation of RUS in Scopus in Scopus facilitated that a greater number of UCf articles became visible, which in turn had a positive impact on indicators such as the number of articles, number of authors, collaboration and documents approaching the SDGs. Furthermore, it also boosted the increase in number of articles published in Spanish, changed the limited positioning of the documents, and enhanced institutional collaboration inasmuch as promoting higher coverage of disciplines in the fields of social sciences and economics.

As a final word, there is not a strong correlation between the UCf articles and the SDGs, the latter being addressed in only the 39.5% of the total production. Likewise, most publications were made in quartile 4 journals, with an appreciable correspondence between the number of SDGs addressed within one article and the high number of citations produced.

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