Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

Açaí (Euterpe oleracea) Waste Management: mapping the scientific sroduction from 2011 and 2021

Carla Lorena Sandim da Rosa
Mestranda em Ciências com ênfase em Ecologia Aplicada, USP/ESALQ, Brasil.
lorenarosa@usp.br

Rodrigo Cândido Passos da Silva
Professor Doutor, UFPA, Brasil.
rodrigo.passos@ufpa.br

Plínio Barbosa de Camargo
Professor Doutor, USP/ESALQ, Brasil.
pcamargo@cena.usp.br

ABSTRACT

The commercial demand for açaí berry has been steadily increasing, accompanied by a rising generation of açaí residue, whether from agro-industrial processes or local sales in Northern Region cities. This study aimed to investigate the state of scientific research on açaí seed residue over ten years. Bibliometrics was employed to map and identify trends in publications related to the topic between 2011 and 2021. It observed that scientific production on the subject is emerging and continually growing, with contributions from researchers from various parts of Brazil and other countries. Furthermore, the discussion on the subject in well-regarded journals with significant impact factors within the academic community demonstrates its promise and interest for future research, particularly as it aligns with sustainable development guidelines. Additionally, the analysis identified six thematic subareas of published works: renewable energy source, pollutant removal, soil conditioner, extractive source for industries, raw material for the construction sector, and eco-efficient management. Açaí berry seed residue can be reused in various ways and has garnered the attention of both the national and international academic communities.

KEYWORDS: Bibliometric analysis; Residues generated in the Amazon; Açaí berry seed.

1 INTRODUCTION

Açaí berry (Euterpe oleracea) is one of the essential palms in the Euterpe genus and is primarily distributed in the Amazon region. The seed is the most significant part of this species but is mainly used for pulp production, typically consumed in Brazil's Northern region. However, due to its chemical properties, primarily its antioxidants, there has been increased commercialization to the rest of the country and the world (DOMINGUES et al., 2017; BURATTO et al., 2021).

With the growing demand for açaí berry, the agroindustry, and high local consumption, and since the mesocarp is the main focus of interest, a significant amount of açaí berry seed or pit residue is generated in the Northern Region, contributing to the clogging streams, sewers, and small rivers (BENTES, 2017). The academic community's interest in açaí berry goes beyond the fruit's beneficial properties for consumption. It extends to the accumulation of waste generated in fruit processing. It has been treated as waste but could be applied in new production chains, such as biomass-based energy production (DE OLIVEIRA et al., 2022).

Research on the reuse of açaí berry residue, providing the conditions to incorporate it into a new production chain, has become standard due to its use for various purposes; it can be used for energy production, construction, various industrial applications, and even pollutant removal (NAGATA et al., 2020; PESSOA et al., 2019; VITRONE et al., 2021; BURATTO et al., 2021).

Beyond scientific publications highlighting the valorization of this residue, the 2030 Agenda (U.N., 2015) encompasses goals and targets for promoting sustainable development (SDGs). In this perspective, SDGs 6, 11, and 12, related to Sanitation, Sustainable Cities, and Responsible Production and Consumption, are particularly relevant and intersect with the focal theme.

In addition to international legal instruments, the proper and sustainable management of açaí berry pit residue aligns with national public policies aimed at protecting and ensuring a balanced and healthy environment for present and future generations, as outlined in Article 225 of the Brazilian Federal Constitution (BRASIL, 1988), the National Environmental Policy (BRASIL, 1981), and the National Solid Waste Policy (BRASIL, 2010). These national legal instruments work to minimize and prevent negative impacts on the environment and society from improper disposal and penalize criminal conduct, as established in the Environmental Crimes Law (BRASIL, 1998).

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"
ISSN 1980-0827 – Volume 20, Number 1, Year 2024

In this context, investigations are to mitigate the socio-environmental impacts caused by the overproduction of açaí berry and the increasing generation of pits under the cyclical and sustainable management framework. Bibliometrics aids in mapping and determining trends in scientific publications on a specific topic, providing an overview of the published works and discussions from a statistical and quantitative perspective. According to Martínez-Lopez et al. (2019), this methodology is highly effective in developing a comprehensive understanding of a research field as it utilizes various indicators.

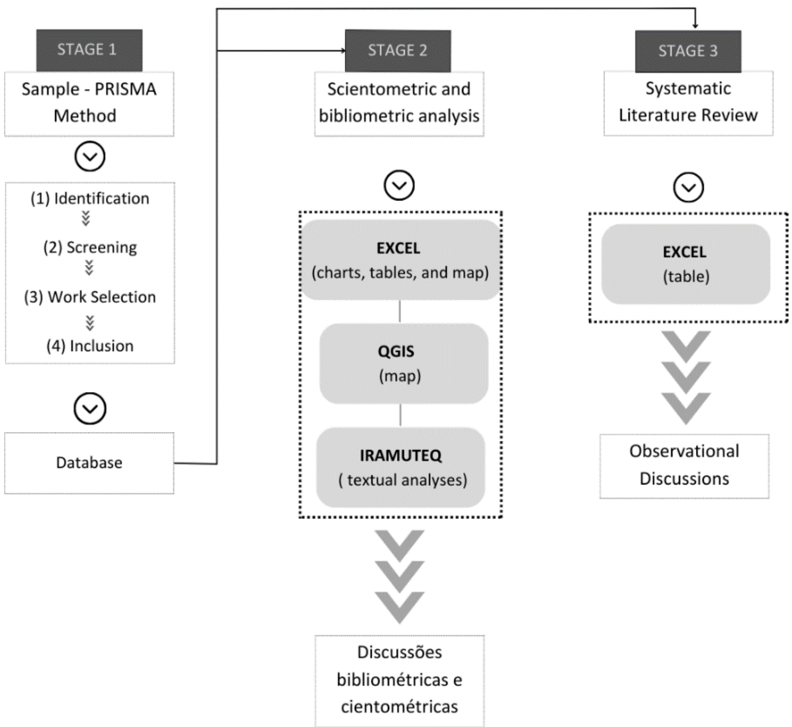
2 OBJECTIVES

To map scientific publications on açaí residue (Euterpe oleracea) between 2011 and 2021 to inform proper and sustainable management and disposal of this residue.

3 METHODOLOGY

The research procedures followed the methodological recommendations proposed by Guedes et al. (2022), as outlined in Figure 1. Thus, we adopted three stages: the collection of articles, bibliometric and scientometric analysis, and a systematic literature review. We conducted the data collection in February 2022.

Figure 1 - Macrological representation of the methodology employed in the research.



Source: Adapted from Guedes et al. (2022)

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

We conducted the article collection process in January 2022 on the following platforms: Science Direct, Scopus, Web of Science, and Scielo. Based on the work of Page et al. (2022), the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method was used to select the sample. The publication period considered for the survey was from 2011 to 2021.

For this, a combination of keywords was employed, including "solid waste" AND "açaí waste," "solid waste management" AND "açaí waste," and "açaí waste" AND "technological routes." The Mendeley software was used for screening the articles found, combined with dynamic reading, to exclude articles that did not fit the thematic focus.

During the study, The Excel software assisted in analyzing the accumulated production of scientific articles related to the focal theme. In addition, we prepared tables with data on authors, institutions, and their spatial distribution, mapping the distribution and frequency of global academic production, following the guidance of LI, HAN, and L.U. (2018). To create the map, we used the Qgis software.

For a qualiquantitative analysis, we prepared a table to identify the scientific journals where the works were published and their respective Qualis ratings, according to the Coordination for the Improvement of Higher Education Personnel (Capes) of the Ministry of Education (MEC). We conducted the studies in 2013-2016 in the following knowledge areas: Engineering I and Environmental Sciences. According to Capes (2016), programs in sub-areas such as Civil Engineering, Environmental Engineering, and Sanitary Engineering, among others, fall under the "Engineering I" category, and interdisciplinary areas focused on socio-environmental issues fall under "Environmental Sciences." Additionally, we evaluated the SCImago Journal Rank (SJR) for 2020, representing a measure of scientific influence, meaning the number of citations of the published article and the journal's relevance (MCALEER; OLÁH; POPP, 2018).

We used the software Iramutec for textual analysis, which involved analyzing the similarity between the terms in the keywords. Initially, a database was created by compiling all the keywords from the articles separately into a single .txt format text document, selecting words repeated more than 20 times, including adjectives, nouns, and verbs. Iramuteq is statistically reliable and offers various tools for corpus analysis. It is also easy to access and use, significantly contributing to academic research (CAMARGO; JUSTO, 2013).

We conducted a systematic literature review to understand the thematic focus of the studies on açaí residue. The selected articles were read and categorized into six thematic subareas: renewable energy source, pollutant removal, soil conditioner, extractive source for industries, raw construction material, and eco-efficient management.

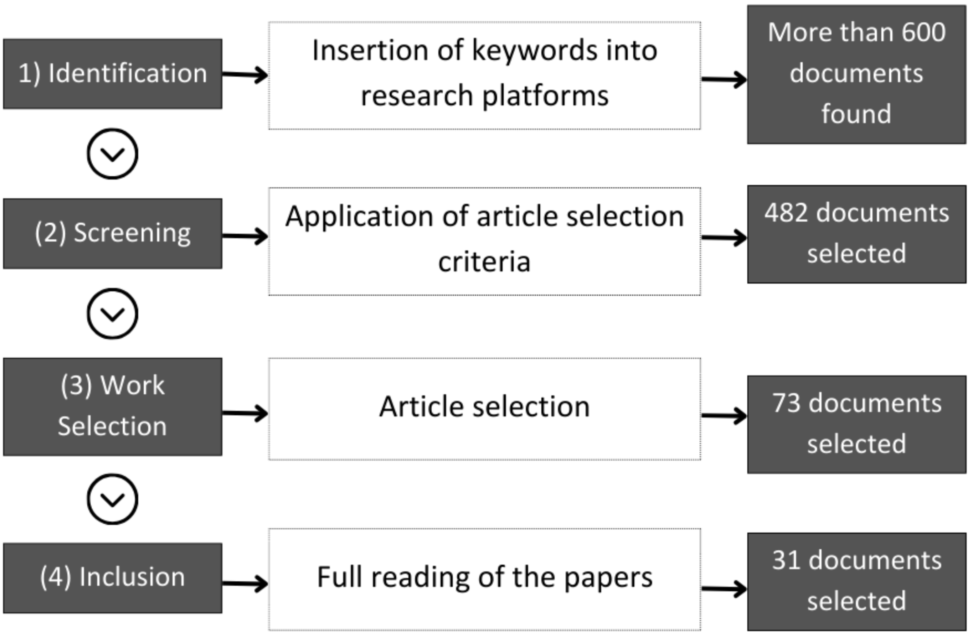
4 RESULTS AND DISCUSSION

The results indicated that out of the initial set of over 600 identified articles, only 31 encompassed topics related to the management and disposal of açaí residues, which accounted for less than 5% of the total number of initially collected works. We also found that, after screening, approximately 42% of the initially selected articles were in the research. At the same time, the rest consisted of duplicates and works unrelated to the focal theme.

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

Figure 2 - Results found in the application of the PRISMA methodology



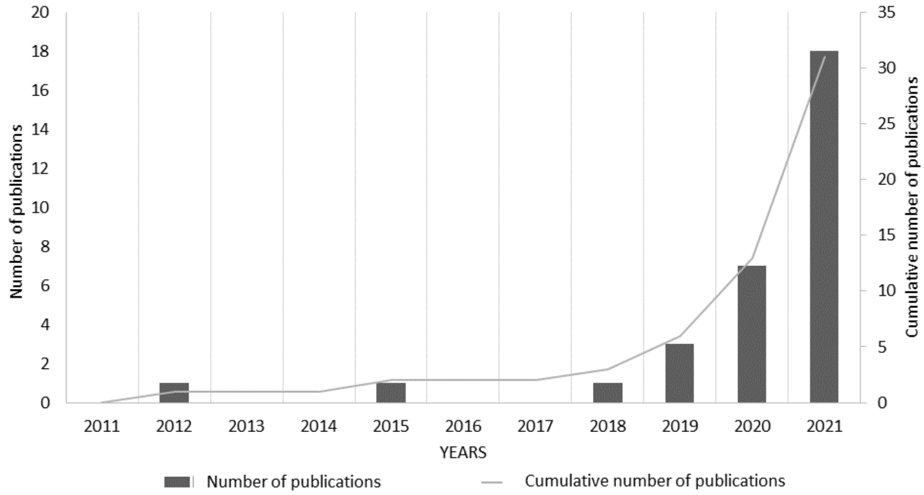
Source: Authors (2022)

When observing the cumulative production of articles on açaí residue management over the years (Figure 3), it was found that only two works were published between 2011 and 2015, accounting for 6.45% of the sample. Between 2016 and 2018, only one work was published on this topic. Since 2019, there has been a significant increase in the publication of articles on this subject, accounting for 90% of the selected works, with a notable peak in 2021. Given the significant production, commercialization, and global visibility that açaí has achieved, the academic community from various continents has been studying both the fruit and the residues generated from the pulp extraction process. These studies cover a range of topics, including management, technologies that generate products of interest to the cosmetics and food industries, energy generation, and more (SÁNCHEZ et al., 2015; FERREIRA et al., 2021; BURATTO et al., 2021).

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

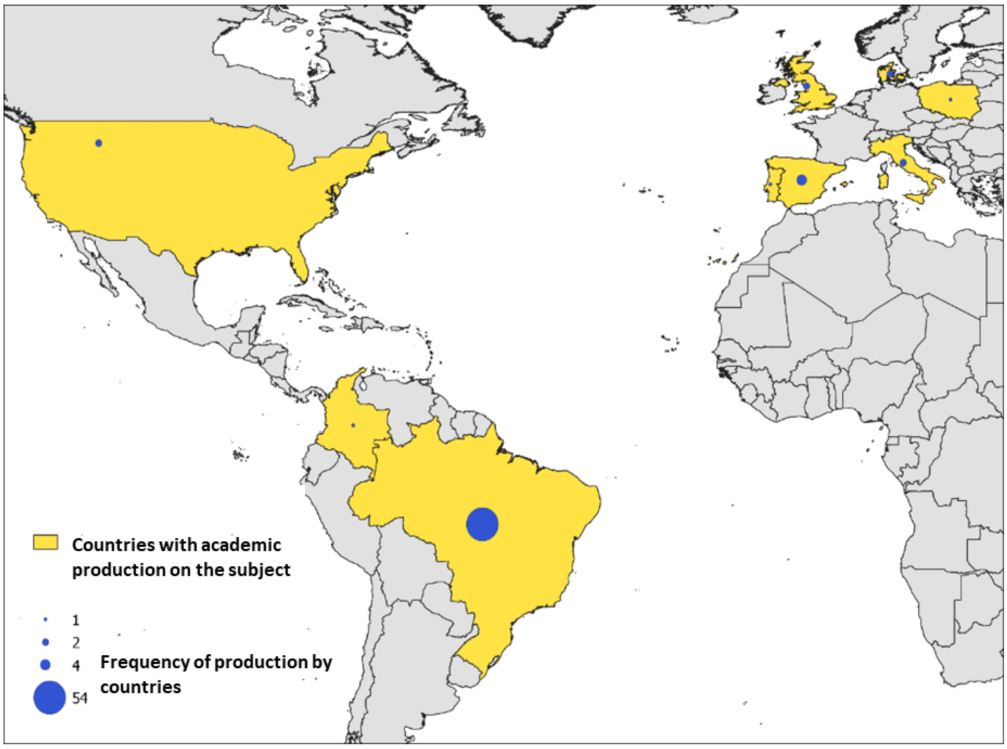
Figure 3 - Cumulative production of articles on açaí residue management between 2011 and 2021



Source: Authors (2022)

National research on açaí residue is still emerging, although international institutions are working on the subject. In this regard, we found publications in various South and North American and European countries. However, the highlight of this production is reserved for Brazil (Figure 4). According to Yamanaka (2012), due to the extensive promotion of the fruit's nutritional and beneficial properties, açaí has transitioned from being consumed primarily locally to becoming of interest to national and international markets.

Figure 4 - Distribution and frequency of publications worldwide



Source: Authors (2022)

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

The seed, locally referred to as the "caroço," is the primary residue generated during açaí processing, and it is a biomass with high calorific value. It represents a renewable energy source with bioenergetic potential for developed and developing countries (BORGES et al., 2017). The authors emphasize the importance of reintegrating this material into the promotion of production and market chains, aspects that contribute to the expansion of açaí consumption, and the use of the residue in the production cycle in countries outside Brazil.

We observed that regarding authorship by institutions with publication on the subject, the Federal University of Pará (UFPA) stood out with 26 authors, followed by the Federal University of Amazonas (UFAM) with 21 authors. It is worth noting that both of these educational institutions are in the Northern Region, which is characterized by high açaí consumption and residue generation, leading to a concern to minimize and address this environmental challenge. Pará is the largest açaí producer in the country, and according to

Tavares et al. (2017) estimate that Pará state consumes 60% of the production. Outside the Northern Region, São Paulo and Pernambuco were the states with the most authors involved in publications on the subject, with the University of Campinas (UNICAMP) and the Federal University of Pernambuco (UFPE) being the institutions actively contributing to academic production in their respective states. On the global stage, Spain was noteworthy, with the participation of seven authors.

Table 1 - Classification of authorship by institutions

Continent	Country	Institution	Authorships
	Brazil	Federal University of Pará	26
		Federal Institute of Pará	3
		Embrapa Eastern Amazon	1
		Federal Rural University of the Amazon	2
		Evandro Chagas Institute	1
		Amazonas State University	1
		Federal University of Amazonas	21
		Federal Institute of Amazonas	1
		National Institute for Amazon Research	1
		Maranhão State University	2
		State University of Maranhão's Tocantina Region	1
		Federal University of Piauí	1
		Federal Rural University of Pernambuco	2
		Federal University of Pernambuco	11
		Federal Institute of Pernambuco	1
South America		Federal University of Paraíba	4
		Federal University of Alagoas	6
		Federal University of Bahia	3

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

		Federal University of Itajubá	6
		Federal University of Lavras	3
		University of Campinas	12
		University of São Paulo	4
		Federal University of São Carlos	1
		University of Araraquara	3
		State University of Rio de Janeiro	3
		Federal University of Rio de Janeiro	8
		National Institute of Technology	1
		Embrapa Forests	1
		Federal University of Santa Catarina	4
		Albrecht Industrial Equipment	2
	Colombia	Pontifical Bolivarian University	1
Europe	Portugal	University of Porto	1
	Spain	University of Cádiz	1
		University of Santiago de Compostela	1
		University of Valladolid	3
		Rovira i Virgili University	2
	Italy	The University of Cassino and Southern Lazio	2
		University of Naples Federico II	2
	Denmark	University of Denmark	1
		Technical University of Denmark	1
	Poland	Maria Curie-Sklodowska University	1
	United Kingdom	University of Nottingham	1
		University Park	1
North America	United States	Kent State University	2

Source: Authors (2022)

The results indicated that the selected articles for the study were published in 24 different journals (Table 1). The standout journal was the Journal of Cleaner Production, with four articles, followed by Bioresource Technology Reports, Energy Conversion and Management, Journal of Environmental Management, and Environmental Science and Pollution Research, each with two articles. The remaining journals were published on the topic only once.

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

Table 2 - Number of publications and classification of journals by evaluation area

Journals	Quantity (n)	SJR	QUALIS/CAPES (Engineering 1)	QUALIS/CAPES (Environmental Sciences)
Journal of Cleaner Production	4	1,93	A1	A1
Renewable and Sustainable Energy Reviews	1	0	A1	A1
Bioresource Technology Reports	2	0,96	Without Qualis	Without Qualis
Fuel	1	1,56	A1	A1
Chemical Engineering and Processing – Process Intensification	1	0	A2	A2
Journal of Environmental Chemical Engineering	1	0,96	B1	A1
Sustainable Materials and Technologies	1	0	B3	B1
Chemosphere	1	1,63	A1	A1
Process Safety and Environmental Protection	1	0	A1	A2
Energy Conversion and Management	2	2,74	A1	A1
Journal of Environmental Management	2	1,44	A1	A1
Journal of Hazardous Materials	1	0	A1	A1
Journal of Building Engineering	1	0,97	B2	Without Qualis
Biofuels, Bioproducts, e Biorefining	1	0,93	A2	A1
Biomass Conversion and Biorefinery	1	0,59	Without Qualis	Without Qualis
Industrial Crops & Products	1	1,06	A1	A1
Renewable Energy	1	1,82	A1	A1
Biomass and Bioenergy	1	1,04	A2	A1
Molecules	1	0,78	B1	A2
Ambiente Contábil Journal	1	0	Without Qualis	B4
Environmental Science and Pollution Research	2	0,84	A1	A1
Waste and Biomass Valorization	1	0,61	A2	B1
Environmental Nanotechnology, Monitoring & Management	1	0,85	Without Qualis	Without Qualis
Waste Management	1	1,81	A1	A1

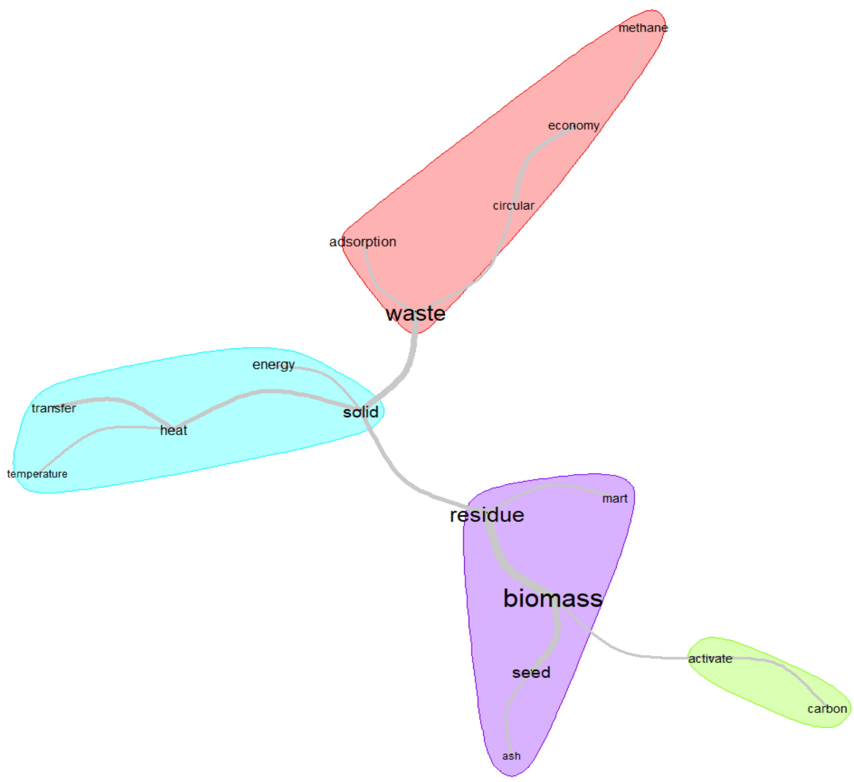
Source: Authors (2022)

We found that 45.8% of the journals obtained classification as Qualis A1 for Engineering 1 and Environmental Sciences, and only 12.5% with the classification as "Sem Qualis" (without Qualis rating) for both knowledge areas. In the Engineering 1 field, precisely 50% of the journals that published articles with classification as Qualis A1, 16.7% as Qualis A2, 8.3% as Qualis B1, 4.2% as Qualis B2, 4.2% as Qualis B3, and 16.7% as "Sem Qualis." In the field of Environmental Sciences, 58.3% of the journals obtained classification as Qualis A1, 12.5% as Qualis A2, 8.3% as Qualis B1, 4.2% as Qualis B4, and 16.6% as "Sem Qualis."

In evaluating the SCImago Journal Rank (SJR), the journal "Energy Conversion and Management" had the highest index. Additionally, we noted that 25% of the journals had no SJR registration.

The proximity connections between words, analyzed with the IRAMUTEQ software, formed four groups interconnected with each other, stemming from a central group (Figure 5), in which the terms "biomass" and "residue" exerted significant influence. The standout term represented a different group of connectedness; therefore, the highlights for the derived branches were "waste," "solid," "activate," and "carbon." The similarity analysis aims to understand the proximities and relationships between elements within a whole and is a graphical representation of the textual corpus (MARCHAND; RATINAUD, 2012). Açaí residue, specifically the pit or seed, is a lignocellulosic biomass that can be converted into bioenergy (SANTOS et al., 2020) and is among the leading research trends in the articles found.

Figure 5 - Similarity analysis performed with the keywords from the articles



Source: Authors (2022)

The Systematic Literature Review of the selected articles identified the structuring of six main thematic lines studied in the published articles, namely: renewable energy source (FER), pollutant removal (R.P.), soil conditioner (C.S.), extractive source for industries (FEI), raw construction material (MPCC), and eco-efficient management (GEE) (Table 3). We found that the 31 published articles were primarily categorized under the subareas FER and R.P., accounting for 38.71% and 35.48%, respectively. In contrast, two articles were published for the other subareas analyzed, equivalent to 6.45% of the sample.

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

Table 3 - Analyzed articles classified into subareas

Subáreas	Títulos	Ano
FER	Renewable energy generation for the rural electrification of isolated communities in the Amazon Region	2015
	Pyrolysis of acai seed biomass: Kinetics and thermodynamic parameters using thermogravimetric analysis	2020
	Acai seed ash as a novel essential heterogeneous catalyst for biodiesel synthesis: Optimization of the biodiesel production process	2021
	Integration of subcritical water pretreatment and anaerobic digestion technologies for valorization of açai processing industries residues	2019
	Magnetic acid catalyst produced from acai seeds and red mud for biofuel production	2021
	Process intensification for the recovery of methane-rich biogas from dry anaerobic digestion of açaí seeds	2021
	Valorization of acai bio-residue as biomass for bioenergy: Determination of effective thermal conductivity by an experimental approach, empirical correlations, and artificial neural networks	2021
	Coupled heat and mass transfer modeling in convective drying of biomass at particle-level: Model validation with experimental data	2020
	Analysis of the isothermal condition in drying of acai berry residues for biomass application	2020
	Briquettes of acai seeds: characterization of the biomass and influence of the parameters of production temperature and pressure in the physical-mechanical and energy quality	2022
	Dry Anaerobic Digestion of Food Industry by-Products and Bioenergy Recovery: A Perspective to Promote the Circular Economy Transition	2022
	Characterization of agroindustrial solid residues as biofuels and potential application in thermochemical processes	2012
R.P.	Insights on preparation and characteristics of KOH-doped carbons derived from an abundant agro-industrial waste in Brazil: Amazon açaí berry seeds	2021
	Açaí waste benefits from the gasification process and its employment in the treatment of synthetic and raw textile wastewater	2019
	Caffeine removal using activated biochar from açaí seed (Euterpe et al.): Experimental study and description of adsorbate properties using Density Functional Theory (DFT)	2021
	Utilization of acai stone biomass for the sustainable production of nanoporous carbon for CO2 capture	2020
	The addition of biochar as a sustainable strategy for the remediation of PAHecontaminated sediments	2021
	Activated carbon obtained from Amazonian biomass tailings (acai seed): Modification, characterization, and use for removal of metal ions from water	2020
	Insight on açaí seed biomass economy and waste cooking oil: Eco-sorbent castor oil-based	2021
	Detoxification of sisal bagasse hydrolysate using activated carbon produced from the gasification of açaí waste	2021
	Composite of iron phosphate-supported carbon from the açaí (Euterpe oleracea) as a solid catalyst for photo-Fenton reactions	2021
	Low-temperature sulfonation of acai stone biomass-derived carbons as acid catalysts for esterification reactions	2019
	Brazilian açaí berry seeds: an abundant waste applied in the synthesis of carbon-based acid catalysts for transesterification of low-free fatty acid waste cooking oil	2021
C.S.	Chemical and mineralogical characterization and potential use of ash from Amazonian biomasses as an agricultural fertilizer and for soil amendment	2021
	Biochar as a sustainable alternative to acaí waste disposal in Amazon, Brazil	2020
FEI	Characterization of industrial açaí pulp residues and valorization by microwave-assisted extraction	2021
	Açaí (Euterpe oleracea Mart.) Seed Extracts from Different Varieties: A Source of Proanthocyanidins and Eco-Friendly Corrosion Inhibition Activity	2021
MPCC	Binderless fiberboards for sustainable construction. Materials, production methods, and applications	2021

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 1, Year 2024

	Eco-particleboard manufactured from acai's chemically treated fibrous vascular tissue (Euterpe et al..) Fruit: A new alternative for the particleboard industry with its potential application in civil construction and furniture	2018
GEE	Waste management and bioenergy recovery from açaí processing in the Brazilian Amazonian region: a perspective for a circular economy	2021
	Treatment and Analysis of Açaí Production Residues: A Study from the Perspective of Eco-efficiency	2020

Source: Authors (2022)

Legend: FER - Renewable Energy Source; R.P. - Pollutant Removal; C.S. - Soil Conditioner; FEI - Extractive Source for Industries; MPCC - Raw Material for Construction; GEE - Eco-efficient Management.

Regarding the number of publications per subarea, we noted that only the subarea FER published articles in 2022, with two works. Most publications concentrate in 2021, with a highlight in the R.P. subarea, which had seven articles, followed by FER with four articles. In this perspective, the subareas FER and R.P. stood out, accounting for 35.71% and 39.29% of the publications produced since 2019.

The studies portray açaí residue as a result of significant agroindustry in fruit processing, and the majority have a technical-technological bias. However, despite this, concerns related to socio-environmental and economic issues are underlying, as the studies show ways to reintegrate an abundant residue into a new production chain, which would connect these subjects in an inter- and transdisciplinary manner. According to Domingues et al. (2017), in Northern Brazil, açaí seeds are considered urban waste that affects city sanitation, and even though they are used in composting techniques and burned for thermal energy generation, the quantity of generated waste, there is no absorption by these implemented forms of reuse.

CONCLUSION

The discussion surrounding açaí residue, as evidenced by bibliometrics and data systematization, is an emerging theme that has been increasingly discussed since 2019, disseminated by researchers from Brazil and various other countries. The largest concentration of research is in the Northern Region of the country. However, there is consistent academic production on the subject in other regions, such as the Northeast and Southeast. The European continent is the most prolific in the international scenario, with researchers from 6 countries involved. More than 50% of the journals published on the subject are well-rated, with Qualis A1, according to the Coordination for the Improvement of Higher Education Personnel (Capes) under the Ministry of Education (MEC).

Among the found works, there is a greater interest in biomass as an energy source. However, there are discussions about implementing the residue in new production chains, such as an extractive source for the food and pharmaceutical industries. In addition, there are discussions about other forms of reuse, such as raw materials for the construction and furniture industries, components for products that assist in pollutant removal, and usage for soil improvement.

In this way, the national and international academic community is increasingly discussing the subject of açaí pit residue, seeking ways to reduce the socio-environmental impacts caused by intensive fruit processing due to increased market demands. The subject lies at the heart of the sustainable development theme, as it is necessary to find environmentally appropriate and socially just ways to mitigate the consequences left by waste generation.

References

BENTES, V. L. I. Preparation and characterization of composites based on iron phosphates supported in activated carbons of acai pits residues and the endocarp of *tucumã* for environmental application. Federal University of Amazonas, Manaus, 2017.

BORGES, A. C. P.; SILVA, M. S.; ALVES, C. T.; TORRES, Renewable energies: a contextualization of biomass as an energy source. REDE - Revista Eletrônica do PRODEMA, Fortaleza, v. 10, n. March 02, 2017. ISSN 1982-5528.Available in: <http://www.revistarede.ufc.br/rede/article/view/239>. Access on March 08, 2022.

BRAZIL. Law nº 6.938, August 31, 1981. It Provides for the National Environment Policy. Brasília, 1981. Available in:< L6938 (planalto.gov.br)>. Accessonn Jun. 18, 2023.

BRAZIL. Constitution of the Federative Republic of Brazil. Brasília, 1988. Available in:<Constituição (planalto.gov.br)>. Access on June 18, 2023.

BRAZIL. Law nº 9.605, February 12, 1998. It Establishes the Environmental Crimes Law. Brasília, 1998. Available in:< L9605 (planalto.gov.br)>. Access on June 18, 2023.

BRAZIL. Law nº 12.305, August 02, 2010. It Establishes the National Solid Waste Policy. Brasília, 2010.Available in:< L12305 (planalto.gov.br)>. Access on June 18, 2023.

BURATTO, R. T.; COCERO, M. J.; MARTÍN, A. Characterization of industrial assai pulp residues and valorization by microwave-assisted extraction. **Chemical Engineering and Processin-Process Intensification**, 2021. DOI:https://doi.org/10.1016/j.cep.2020.108269.Available in: <https://www.sciencedirect.com/science/article/pii/S0255270120307315?via%3Dihub >. Access on March 08, 2022.

CAMARGO, B. V.; JUSTO, A. M. IRAMUTEQ: free software for analysis of textual data. Themes in psychology, v. 21, n. 2, p. 513-–18, 2013. Available in: < http://pepsic.bvsalud.org/pdf/tp/v21n2/v21n2a16.pdf > Access on Mar, 27. 2022.

CAPES - Coordination of Improvement of Higher Level Personnel. **OInthe areas of evaluation. Environmental sciences**, 2016, Available in: <https://capes.gov.br/images/documentos/Documentos_de_area_2017/49_CAMB_docarea_2016__publ2.pdf.> Access on February 18, 2022.

DE OLIVEIRA, P. R. S.; TRUGILHO, P. F.; DE OLIVEIRA, T. J. P. Briquettes of açai seeds: characterization of the biomass and influence of the parameters of production temperature and pressure in the physical-mechanical and energy quality. **Environmental Science and Pollution Research**, v. 29, n. 6, p. 8549–8558, 2022. DOI: https://doi.org/10.1007/s11356-021-15847-6. Available in: <https://link.springer.com/article/10.1007/s11356-021-15847-6> Access on March 22, 2022.

DOMINGUES, A. F. N.; MATTIETTO, R. A.; OLIVEIRA, M. S. P. Lipid content in Euterpe oleracea Mart. Embrapa, Eastern Amazonia. **Bulletin of Research and Development**, 2017.Available in: <https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1062268/1/BOLETIMPD115Ainfo.pdf > Access March 16, 2022.

FERREIRA, S. F.; BULLER, L. S.; MACIEL-SILVA, F. W.; SGANZERLA, W. G.; BERNI, M. D.; FORSTER-CARNEIRO, T. Waste management and bioenergy recovery from açaí processing in the Brazilian Amazonian region: A perspective for a circular economy. **Biofuels Bioprod Biorefin**. v. 15, n. 1, p. 37-46, Jan/Feb. 2021. DOI: https://doi.org/10.1002/bbb.2147. Available in: <https://onlinelibrary.wiley.com/doi/10.1002/bbb.2147> Access on March 16, 2022.

GUEDES, F. L.; EL-DEIR, S. G.; JÚNIOR, W. R. A.; JUCÁ, J. F. T. Analysis of scientific production of refused derived fuel through scientometric and bibliometric indicators. **Journal of Environmental Analysis and Progress**, [S. l.], v. 7, n. 2, p. 052–061, 2022.

LI, N.; HAN, R.; L.U., X. Bibliometric analysis of research trends on solid waste reuse and recycling during 1992–2016. **Resources, Conservation and Recycling**, v. 130, p. 109-117, 2018. DOI: https://doi.org/10.1016/j.resconrec.2017.11.008. Available in: <https://www.sciencedirect.com/science/article/pii/S0921344917303841> Access on March 16, 2022.

LIU, W.; WANG, J.; LI, C.; CHEN, B.; SUN, Y. Using Bibliometric Analysis to Understand the Recent Progress in Agroecosystem Services Research. **Ecological Economics**, v. 156, p. 293–305, 2019. DOI: https://doi.org/10.1016/j.ecolecon.2018.09.001. Available in: <https://www.sciencedirect.com/science/article/pii/S0921800918302192?via%3Dihub> Access on March 6, 2022.

MARCHAND, P.; RATINAUD, P. P. The similarity analysis applied to textual corpus: the socialist primaries for the French presidential election (September-October 2011). **Proceedings of the 11th International Days of Statistical Analysis of Textual Data. JADT**, v. 2012, p. 687-699, 2012.

MARTÍNEZ-LÓPEZ, F. J.; MERIGÓ, J. M.; GÁZQUEZ-ABAD, J. C.; RUIZ-REAL, J. L. Industrial marketing management: Bibliometric overview since its foundation. **Industrial Marketing Management.** v.84, p.18-39, 2019. DOI: https://doi.org/10.1016/j.indmarman.2019.07.014.

MCALEER, M.; OLÁH, J.; POPP, J. Pros and cons of the impact factor in a rapidly changing digital world, **Tinbergen Institute Discussion Paper**, v. 14, p. 36, 2018. DOI: https://doi.org/10.21680/2176-9036.2020v12n2ID18923

NAGATA, G. A.; SOUTO, B. A.; PERAZZINI, M. T. B.; PERAZZINI, H. Analysis of the isothermal condition in drying acai berry residues for biomass application. **Biomass and Bioenergy**, v. 133, p. 105453, 2020. DOI: https://doi.org/10.1016/j.biombioe.2019.105453. Available in: <https://www.sciencedirect.com/science/article/pii/S0961953419304027?via%3Dihub> Access on March 25, 2022.

UNITED NATIONS - (U.N.). Agenda 2030 and the Sustainable Development Goals. New York, (2015). Available in:< Sustainable Development Goals | The United Nations in Brazil>. Access on: June 18, 2023.

Page, M. J.; McKenzie, J. E.; Bossuyt, P. M.; Boutron I, Hoffmann T. C.; Mulrow, C.D et al. The PRISMA statement, 2020: updated guideline to report systematic reviews. Rev Panam Salud Publica. 2022;46:e112. https://doi.org/10.26633/RPSP.2022.112PESSOA, T. S.; LIMA, L.; SILVA, M. P. da.; NETO, L. M. P. Açaí waste benefiting by gasification process and its employment in the treatment of synthetic and raw textile wastewater. **Journal of Cleaner Production**, v. 240, p. 118047, 2019. DOI: https://doi.org/10.1016/j.jclepro.2019.118047

SÁNCHEZ, A. S.; TORRES, E. A.; KALID, R. A. Renewable energy generation for the rural electrification of isolated communities in the Amazon Region. **Renew. Sustain. Energy Rev**., 49. pp. 278–290, 2015. DOI: http://dx.doi.org/10.1016/j.rser.2015.04.075

SANTOS, V. O.; QUEIROZ, L.; ARAUJO, R., O.; RIBEIRO, F. C. P. Pyrolysis of acai seed biomass: Kinetics and thermodynamic parameters using thermogravimetric analysis. **Bioresource Technology Reports**, v. 12, p. 100553, 2020.

TAVARES, G. S; HOMMA, A. K. O; MENEZES, A. J. E. A. de. Marketing of açaí pulp in the state of Pará. In: SOBER SYMPOSIUM NORTH, 1., 2017, Belém, PA. **Anais**. Belém, PA: SOBER NORTE, 2017. p. 297–301. Available in: <https://www.alice.cnptia.embrapa.br/alice/bitstream/doc/1074306/1/SoberNorte201711.pdf> Access on March 07, 2022.

VITRONE, Federica.; RAMOS, D.; FERRANDO, F.; SALVADÓ, j. Binderless fiberboards for sustainable construction. Materials, production methods, and applications. **Journal of Building Engineering**, v. 44, p. 102625, 2021. DOI: https://doi.org/10.1016/j.jobe.2021.102625. Available in: <https://www.sciencedirect.com/science/article/pii/S2352710221004836?via%3Dihub>. Access on March 28, 2022.

YAMANAKA, E.S. Cultivation, extraction and processing of organic acai. **Technical Dossier**. Paulista State University, SIRT/UNESP, 2012. Available in: <http://sbrt.ibict.br/dossie-tecnico/downloadsDT/NjEwOA%3D%3D> Access on March 08, 2022.