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Research Trends on the Use of Avocado Starch for Biofilm Production: Bibliometric Analysis Using VOSviewer

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A B S T R A C T

Avocado starch has gained attention as a potential bio-based material due to its unique features that make it suitable for forming biofilms. This work thoroughly examines the changing field of research focused on using avocado starch for biofilm applications. It uses VOSviewer, a tool for analyzing bibliometric data, to uncover important insights using a database of Scopus-indexed journal publishers. This study aimed to determine research trends on the use of avocado starch for biofilm production. The Scopus database collected information on research trends in the use of avocado starch for biofilm production. To obtain search results, subject categories with titles, keywords, and abstract criteria from the use of avocado starch extraction, biofilm/bioplastic production, and biocomposite were used as a reference. Using VOSviewer, search result extraction was performed. The results of bibliometric mapping were then further evaluated. The findings of the bibliometric study are demonstrated through network visualization, overlay visualization, and density visualization. The findings indicate that starch produced from avocados has the potential to be a viable resource for manufacturing biofilms. However, further investigation is required to enhance the overall quality of the produced biofilm..

1. INTRODUCTION

1.1. Research Background

The use of biodegradable materials has become increasingly popular as a viable approach to tackle environmental issues related to conventional synthetic polymers in order to promote sustainable developments. In light of the increasing environmental issues caused by non-biodegradable plastics, finding eco-friendly alternatives has become essential (1,2,3,4).

The avocado seeds have gained significant attention in discussions about sustainable materials because of their abundant starch content. This makes it a desirable resource for the creation of biofilms. With researchers globally exploring the various uses of avocado starch in the creation of biofilms, it is crucial to comprehend the intricacies of this rapidly developing field of study [5,6,7,8]

Bibliometric analysis is a quantitative approach used to map and evaluate scholarly literature. It is a powerful tool for identifying patterns, collaborations, and research trends in a particular topic. Within this particular framework, the VOSviewer software stands out as a powerful tool that allows for the representation of co-authorship networks, correlations between keywords, and patterns of citations. Our study aims to analyze the existing literature on avocado starch-based biofilms using bibliometric analysis. Through this analysis, we aim to

determine the present level of knowledge, identify areas of research that require further exploration, and highlight collaborative efforts that are influencing the direction of this field.

With this bibliometric analysis, our goal is to enhance our awareness of the worldwide research landscape regarding the use of avocado starch in biofilm applications. Our analysis aims to provide valuable insights for future research, promote collaboration across disciplines, and support the sustainable advancement of biofilm technology by identifying important research areas, significant authors, and emerging trends.

1.2. Research Objective

This study aimed to determine research trends on the use of avocado starch for biofilm production, stimulate educated discussion, and encourage innovative methods **toward** a more sustainable and environmentally conscious future as we explore the complexities of avocado starch's involvement in biofilm research**.**

2. .MATERIALS AND METHODS

This research uses an exploratory, descriptive research type. The method used in this research follows research by Ref. [1]. Figure 1 shows a data search via the Scopus website (www.scopus.com) with the keywords: "TITLE-ABS-KEY (avocado AND starch AND extraction AND for AND bioplastic OR biofilm OR composite)." Documents from the Scopus website are saved in the form of a .ris file type (Figure 2.).

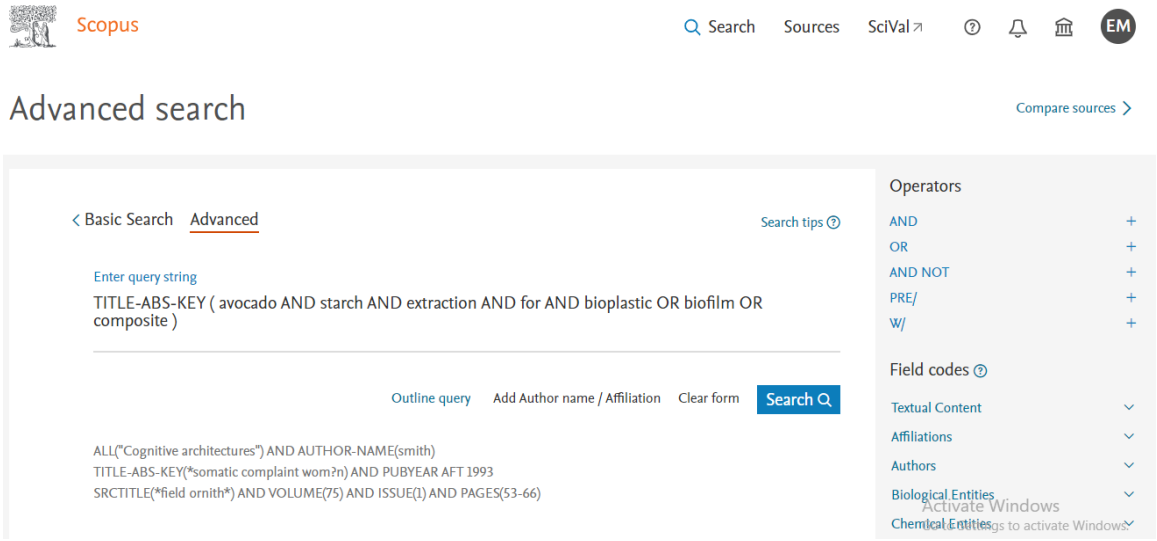

Figure 1. Scopus Search Display with Keywords

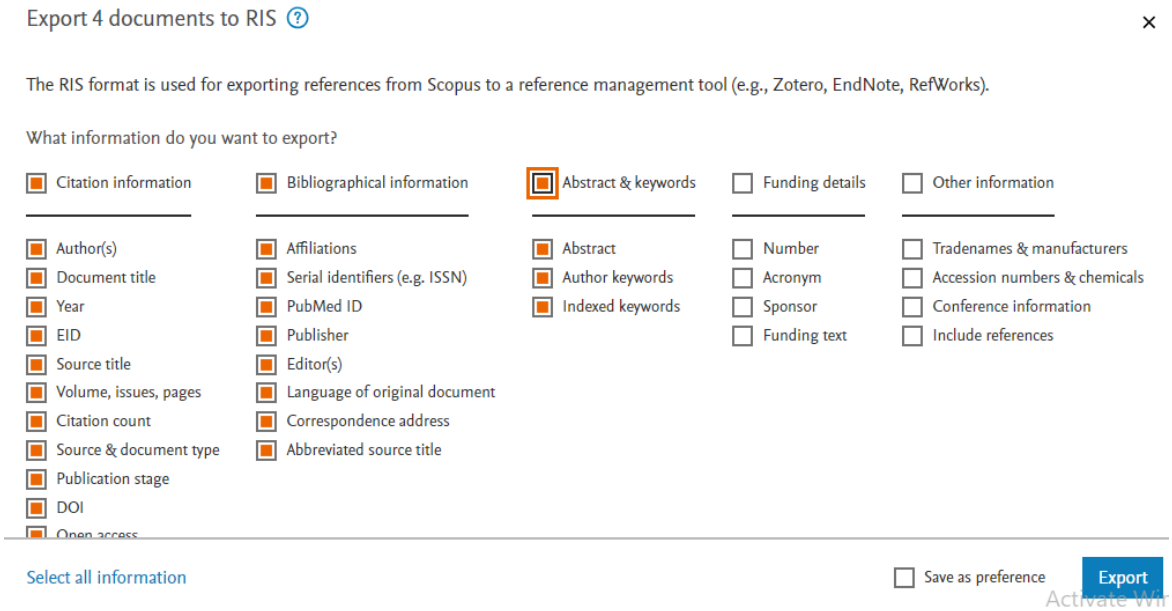

Figure 2. RIS Type File Display

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After obtaining the metadata, each document was then checked manually for completeness of the data using Mendeley Reference Manager software (Figure 3). Complete data such as title, authors, author keywords, and others. It was then analyzed using VOSviewer software version 1.6.18 for Windows (Figure 4.).

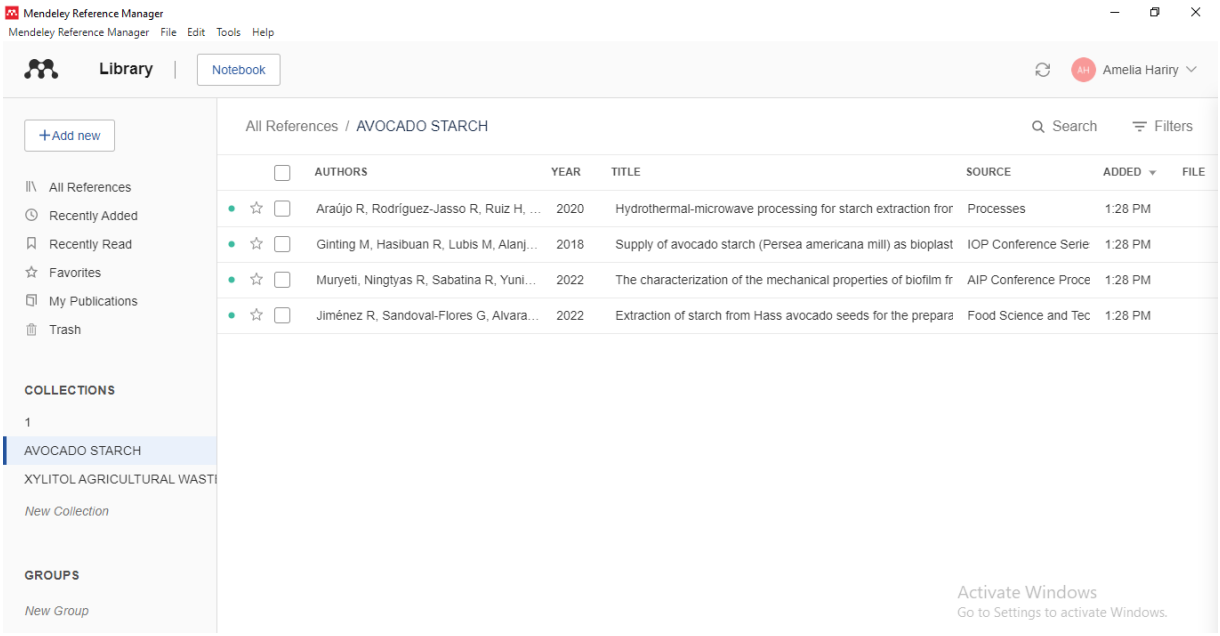

Figure 3. Mendeley Reference Manager Display

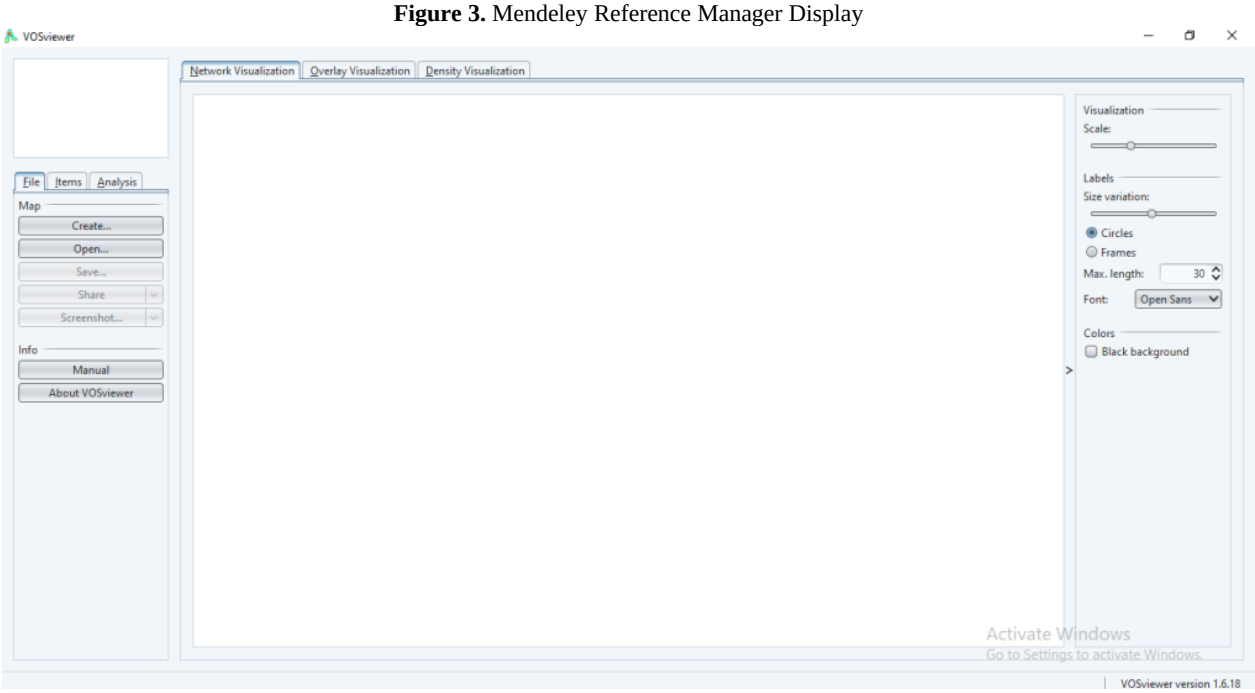

Figure 4. Display of VOSviewer Software Version 1.6.18 for Windows

3. RESULT AND DISCUSSION

3.1. Publication Data Search Results

As of October 5th, 2023, the data obtained from the Scopus database using preset keywords yielded 4 documents. Table 1 displays the document acquired as metadata, which includes the title, author's name, year, and number of citations.

Table 1. Avocado Starch Publication Data in Scopus indexed Journal

No	Title	Authors	Year	Citations
1	The characterization of the mechanical properties of biofilm from avocado seeds and coconut coir fiber	[5]	2022	1
2	Extraction of starch from Hass avocado seeds for the preparation of biofilms	[6]	2022	7
3	Hydrothermal-microwave processing for starch extraction from Mexican avocado seeds: Operational conditions and characterization	[7]	2020	21
4	Supply of avocado starch (Persea americana mill) as bioplastic material	[8]	2018	10

3.2. Publication Trends by Publication Year

Development of research on avocado starch published in Scopus-indexed journals is shown in Table 2. Table 2 shows that the number of research avocado starch for biofilm/bioplastic/composite from 2018-2022 was four documents.

Table 2. Research of Avocado Starch by Year Publication

Publication Year	Number Of Documents
2018	1
2020	1
2022	2

The results of the analysis are that in 2018, it produced one conference paper; in 2020, it produced 1 article; and in 2022, it produced one conference paper and 1 article.

3.3. Publication Trends by Affiliation

In 4 publications, ten affiliates contributed to avocado starch for biofilm/bioplastic/composite. Table 3 shows affiliations in research publications. From the results obtained, these affiliates came from Indonesia, Mexico, and Portugal.

Table 3. Research of Avocado Starch by Affiliation

Affiliation	**Number Of Documents**
National Technological of Mexico	1
Centro de Investigacion en Ciencia Aplicada y Tecnologia Avanzada	1
Centro de Investigacion y de Estudios Avanzados del Instituto Politécnico Nacional	1
Instituto Politécnico Nacional	1
Universidad Autonoma de Coahuila	1
Universidad Autónoma de Tamaulipas	1
University of Indonesia	1
University of Northern Sumatra	1
Jakarta State Polytechnic	1
Universidade Católica Portuguesa	1

The results of the manual analysis also show that several universities from Indonesia published research on avocado starch during the 2018-2022 period. These universities include the University of Indonesia, the University of North Sumatra, and the Jakarta State Polytechnic.

3.4. Research Development Map of Avocado Starch

VOSviewer can display bibliometric mapping in three different visualizations [10], namely Network Visualization (Figure 5), Overlay Visualization (Figure 6), and Density Visualization (Figure 6) of keywords.

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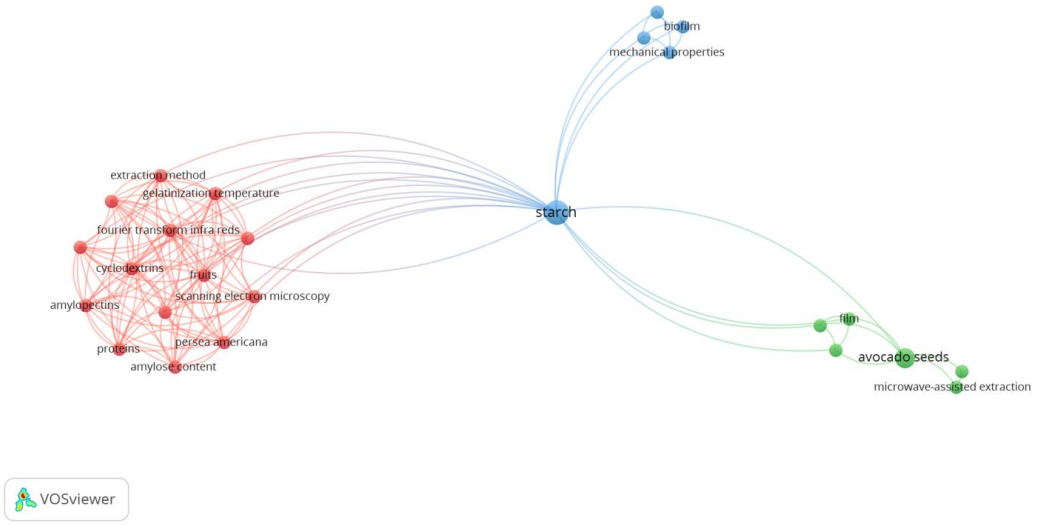

Figure 5. Network Visualization From Avocado Starch Keyword

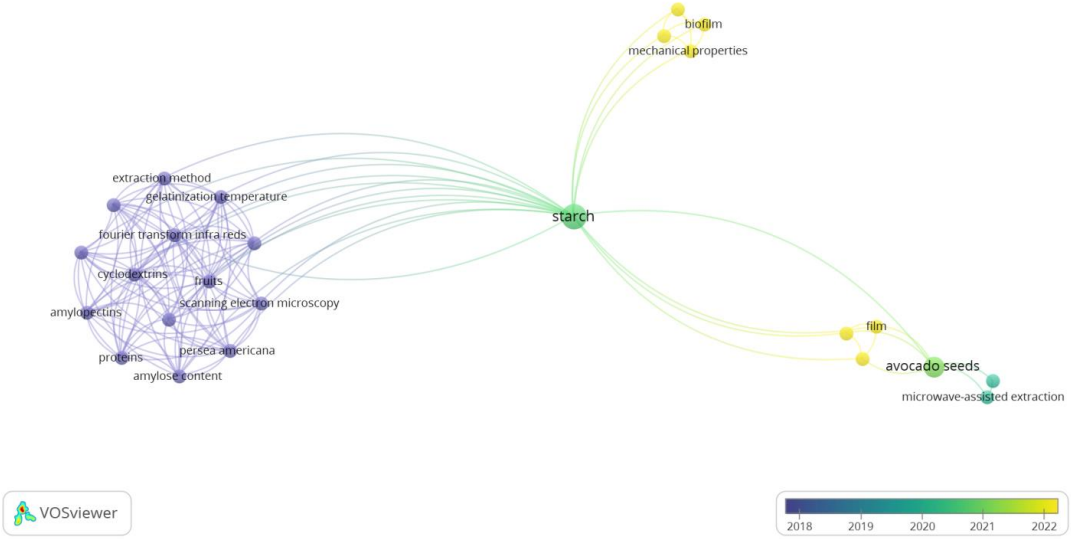

Figure 6. Overlay Visualization From Avocado Starch Keyword

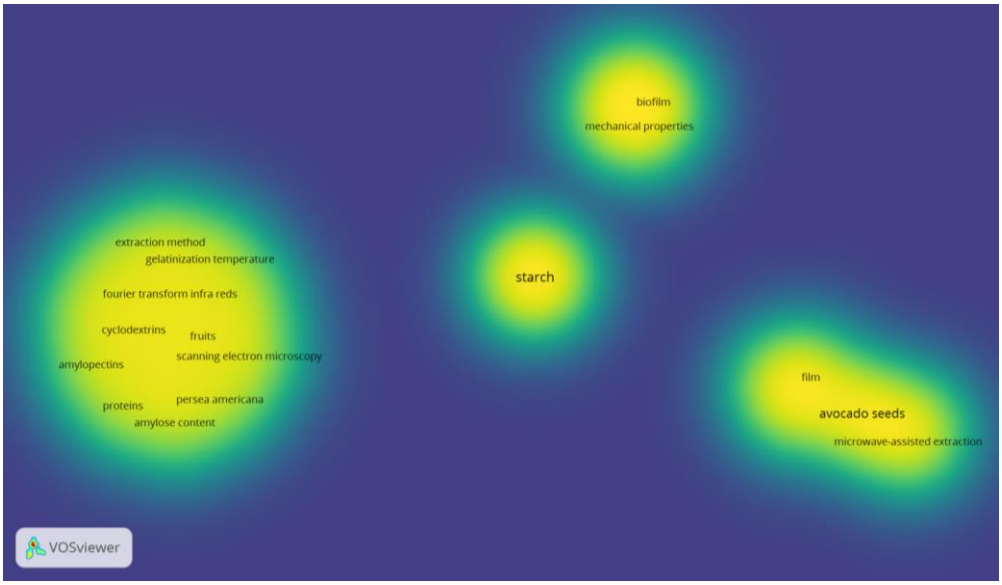

Figure 7. Density Visualization From Avocado Starch Keyword

In network visualization, relationships are represented by networks or lines connecting two keywords [11]. Figure 5 shows a network visualization depicting clusters of selected keywords. Keywords are labeled with colored circles where the more often the keyword appears, the larger the size of the letters and circles. Figure 6 shows an overlay visualization depicting the year in which the most research keywords were found. Figure 7 shows a density visualization that illustrates how often the keyword is used in research, where the brighter the yellow color, the more frequently the keyword is used.

In the article data from the computational mapping, 25 items were found, and in 3 clusters of words, connections from network visualization were obtained from VOSviewer. The division of this cluster is based on a set of terms that are connected. The division of each cluster is as follows:

(i) Cluster 1, marked in red, has 14 items, namely, amylopectins, amylase content, cyclodextrins, extraction method, Fourier transform infrared, fruits, gelatinization temperature, gelation, Persea americana, protein contents, proteins, rapid visco analyzers, scanning electron microscopy, and starch contents.

(ii) Cluster 2, marked in green, has six items, namely, avocado seeds, coconut coir fiber, film, microwave-assisted extraction, starch source, and tensile strength.

(iii) Cluster 3, marked in blue, has 5 items, namely, biofilm, glycerol, hass avocado seed, mechanical properties, and starch.

3.5. Extraction Method of Avocado Starch

Some extraction methods from avocado starch can be seen in Table 4.

Table 4. Research of Avocado Starch extraction method

No	Title Journal	Extraction Method
1	The characterization of the mechanical properties of biofilm from avocado seeds and coconut coir fiber [5]	The avocado seeds were gathered from local markets in Depok, West Java. The avocado seeds were cleansed, pulverized into a fine powder, and, after that, immersed in a 0.01 M solution of sodium metabisulfite for 24 hours. The avocado seeds were subsequently mixed with distilled water until a slurry was created. The slurry underwent filtration, and the resulting filtrate was collected and subjected to precipitation for 24 hours. Subsequently, the pulp of the avocado seeds was rinsed with distilled water, and the resulting liquid was left undisturbed to settle and form a precipitate for 24 hours. The precipitate was subjected to drying in an oven at a temperature of 50°C for 6 hours, resulting in its conversion into starch. Upon completion of the drying process, the starch was meticulously strained using a 100 mesh sieve in order to acquire a refined powder consistency.
2	Extraction of starch from Hass avocado seeds for the preparation of biofilms [6]	The isolation of starch was achieved by employing the Villalobos process [12] with certain modifications. Prior to being sliced into 3 cm pieces, the seed was rinsed with tap water and subsequently with distilled water. A 300 g sample of chopped seed was soaked in distilled water for 24 hours and then pulverized in a food processor (Oster FPSTFP1355 – 500W) to decrease the particle size by filtering it through an 80-micron screen. 1000 mL of distilled water was introduced, let to stand for 1 hour, and subsequently strained through a cloth sieve made of cotton fabric. The dispersion was allowed to rest undisturbed for 12 hours in order to facilitate the sedimentation of starch particles. The suspension was separated and evaporated in an oven (Model 23 Binder, Germany) for 6 hours at 42 °C, pulverized, and stored in an airtight container until needed.
3	Hydrothermal-microwave processing for starch extraction from Mexican avocado seeds: Operational conditions and characterization [7]	Extraction of starch from avocados using Microwave-Assisted Extraction (MAE) The starch was obtained using the process of microwave-assisted extraction (MAE) using the CEM Mars 6 system from the United States. The extraction was carried out in Teflon containers with a capacity of 70 mL, equipped with temperature control, namely the Xpress model. The extraction process involved a ratio of 1:20 (weight/volume), where 20 mL of water was used for every 1 g of dried avocado seed. The extraction was carried out using a frequency of 2.45 GHz and a power of 1200 W [13]. Every treatment was conducted in triplicate. Following extraction, the liquid phase was obtained through filtration. The starch was then precipitated using ethanol in a 1:2 (v/v) ratio. After 12 hours of precipitation, the starch was recovered through decantation and centrifugation at 4000× g for 10 minutes using a Hermle Z326 K centrifuge from Wehingen, Germany. Finally, the starch was freeze-dried [14].
4	Supply of avocado starch (Persea americana mill) as bioplastic material [8]	Obtaining starch from an avocado The avocado seeds are thinly sliced [15,16] with a thickness of approximately 2 mm [17]. They are then thoroughly washed multiple times with water until clean and subsequently dried under direct sunlight for 6 hours. To create the slurry, the dehydrated avocado seeds are mixed with water at a ratio of 1:5 (weight to volume). The avocado seeds were extracted from the filtrate. The starch suspension was chilled and subsequently precipitated through temporal variation. The wet starch was subjected to a drying process in an oven at a temperature of 50°C [18] for approximately 24 hours [19]. The starch is dehydrated, pulverized, and then filtered to achieve a particle size of 100 mesh [20,21].

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3.6. Biofilm Production from Avocado Starch

There are two studies in journals indexed by Scopus Biofilm Production from Avocado Starch (Table 5).

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Table 5. Avocado Starch Publication Data in Scopus indexed Journal

No	Title	Authors	Citations
1	The characterization of the mechanical properties of biofilm from avocado seeds and coconut coir fiber [5]	Avocado seeds starch and coconut fiber were stirred using a hot plate magnetic stirrer. The materials used in this study were the avocado seeds starch with variations of 2%, 4%, 6 %, and 8% (w/v), 1% (w/v) of the cellulose powder, and the sorbitol of 2 ml. The films were made using avocado seeds starch added with cellulose fiber powder and sorbitol, and then distilled water was added until 200 ml. Afterward, the mixture was heated to 90oC and stirred with a magnetic stirrer for 30 minutes. The mixture was poured into the mold and then dried in the oven at 70^{o}C for ±16 hours.	Test results show the optimum value of tensile strength is 2,016 MPa, the elongation percentage is 12.38%, and obtained at the composition of 6% of starch. Thus, it can be concluded that the addition of starch can improve the mechanical properties of films.
2	Extraction of starch from Hass avocado seeds for the preparation of biofilms [6]	The casting method adaptations produced the biofilms. Two types of biofilms were formulated: T1 (biofilm without plasticizer) and T2 (biofilm with plasticizer), maintaining the composition of 2 g of starch in 70 mL of distilled water. A 0.5 mL of glycerol was used as a plasticizer. 70 mL of distilled water were heated by adding 2 g of starch until its gelatinization, maintaining a constant agitation for 30 min. In T2, 0.5 mL of glycerol was added as a plasticizer during the gelatinization. Finally, the starch suspension was transferred to 10 x 10 cm plates and dried for 72 h in an oven at a constant temperature of 30 °C	The glycerol addition allowed us to obtain a biofilm with flexible characteristics, proven by mechanical tests, elongation, and water vapor permeability. In T2, glycerol decreased the tensile strength and improved the water vapor permeability due to its hydrophilic character. The results indicate that it is possible to use Hass avocado seed waste for starch extraction and produce biofilms to give it added value. This biofilm can be used in low-moisture food coatings.

4. CONCLUSION

Bibliometric analysis enhances the study by providing clear theoretical and methodological frameworks that may be employed in many scenarios. The bibliometric study conducted using Vosviewer software reveals significant findings regarding publishing patterns over time, the leading institutions and authors in the field, and the scientific progress made in the area of biofilm from avocado starch. Furthermore, it explores how researchers form mutually advantageous connections with one another through network visualization bibliographies that are based on authors, as well as how research progresses using keywords. The results of the bibliometric analysis, shown using network visualization, overlay visualization, and density visualization, suggest that there is a lack of articles in the Scopus journal on the use of avocado starch for biofilm application. The results suggest that avocado-derived starch shows potential as a feasible material for producing biofilms. Nevertheless, additional research is necessary to improve the overall quality of the generated biofilm.

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REFERENCE

[1] M. Chiumarelli and M. D. Hubinger, “Evaluation of edible films and coatings formulated with cassava starch, glycerol, carnauba wax, and stearic acid,” Food Hydrocoll., vol. 38, pp. 20–27, 2014, doi: 10.1016/j.foodhyd.2013.11.013.

[2] Niranjana, “A Review on Present Status and Future Challenges of Starch Based Polymer Films and Their Composites in Food Packaging Applications,” Polym. Compos., vol. 39, 2018, doi: 10.1002/pc.24236.

[3] A. Valdés, M. Ramos, A. Beltrán, A. Jiménez, and M. C. Garrigós, “State of the art of antimicrobial edible coatings for food packaging applications,” Coatings, vol. 7, no. 4, pp. 1–23, 2017, doi: 10.3390/coatings7040056.

[4] H. Almasi, B. Ghanbarzadeh, and A. A. Entezami, “Physicochemical properties of starch-CMC-nano clay biodegradable films,” Int. J. Biol. Macromol., vol. 46, no. 1, pp. 1–5, 2010, doi: 10.1016/j.ijbiomac.2009.10.001

[5] Muryeti, R. Ningtyas, R. R. Sabatini, and R. T. Yuniastuti, "The characterization of the mechanical properties of biofilm from avocado seeds and coconut coir fiber," in *AIP Conference Proceedings*, 2022, vol. 2493. doi: 10.1063/5.0110820.

[6] R. Jiménez, G. Sandoval-Flores, S. Alvarado-Reyna, S. E. Alemán-Castillo, R. Santiago-Adame, and G. Velázquez, "Extraction of starch from Hass avocado seeds for the preparation of biofilms," *Food Sci. Technol.*, vol. 42, 2022, doi: 10.1590/fst.56820.

[7] R. G. Araújo *et al.*, "Hydrothermal-microwave processing for starch extraction from Mexican avocado seeds: Operational conditions and characterization," *Processes*, vol. 8, no. 7, 2020, doi: 10.3390/pr8070759.

[8] M. H. S. Ginting, R. Hasibuan, M. Lubis, F. Alanjani, F. A. Winoto, and R. C. Siregar, "Supply of avocado starch (Persea americana mill) as bioplastic material," in *IOP Conference Series: Materials Science and Engineering*, 2018, vol. 309, no. 1. doi: 10.1088/1757-899X/309/1/012098.

[9] A. Hariry, E. Mardawati, and N. Masruchin, "Nanocellulose Research Trends from Pineapple Plant Waste in Indonesia : Bibliometric Analysis Using VosViewer," *Asian J. Appl. Res. Community Dev. Empower.*, vol. 7, no. 2, 2023.

[10] A. B. D. Al Husaeni, D. F., and Nandiyanto, "Bibliometric using VOSviewer with Publish or Perish (using Google Scholar data): From step-by-step processing for users to the practical examples in the analysis of digital learning articles in pre and post Covid-19 pandemic," *ASEAN J. Sci. Eng.*, vol. 2(1), pp. 19–46, 2022.

[11] D. Novia, A. Husaeni, A. Bayu, D. Nandiyanto, and R. Maryanti, "Indonesian Journal of Community and Bibliometric Analysis of Special Needs Education Keyword Using VOSviewer Indexed by Google Scholar," *Indones. J. Community Spec. Needs Educ.*, vol. 3, no. 1, pp. 1–10, 2023.

[12] Villalobos, López, Rodríguez, and Prado, "Obtención de almidón a partir de los residuos de papa del mercado Abastos. Guanajuato: Universidad Tecnológica del Suroeste de Guanajuato," 2014.

[13] A. Aguilar-Reynosa, A. Romaní, R. M. Rodríguez-Jasso, C. N. Aguilar, G. Garrote, and H. A. Ruiz, "Comparison of Microwave and Conduction-Convection Heating Autohydrolysis Pretreatment for Bioethanol Production," *Bioresour. Technol.*, vol. 243, pp. 273–283, 2017.

[14] H. A. Ruiz, M. A. Cerqueira, H. D. Silva, R. M. Rodríguez-Jasso, A. A. Vicente, and J. Teixeira, "A. Biorefinery Valorization of Autohydrolysis Wheat Straw Hemicellulose to Be Applied in a Polymer-Blend Film," *Carbohydr. Polym.*, vol. 92, pp. 2154–2162, 2013.

[15] Cinelli, Chiellini, L. J. W, and I. S. H, "Polymer Degradation and Stability," vol. 11, p. 47, 2006.

[16] Srianta, H. B, K. N, and B. P. J, "International Food Research Journal," vol. 19, p. 941, 2012.

[17] Mirhosseini, R. A. Nur Farhana, B. T. A, C. K. W, K. M, and Z. M, "LWT - Food Science and Technology," vol. 63, p. 184, 2015.

[18] M. Lubis, H. M. B, M. A, Alfarodo, G. M. S, and Sartika, "No Title," *J. PhysiConf .Ser*, vol. 80, 2017.

[19] Lopez, "Food Chem," *J. Agric*, vol. 46, p. 3643.

[20] Muaz, F. M, S. M. Y, and H. A. A, "Advances in Environmental Biology," vol. 8, p. 129, 2014.

[21] Silva, M. M, and C. J, "Biotechnology advances," vol. 27, p. 30, 2009.

 https://doi.org/10.29165/ajarcde.v7i3.359