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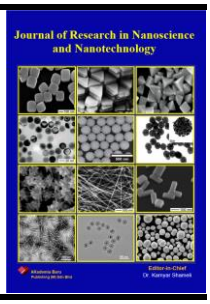

Biodegradable Polymers for Packaging : A Bibliometric Overview of the Publication in Web of Science in Year 2012-2021

Pavithra Siva, Mohammad Ali Tareq*, Kamyar Shameli*

Malaysia-Japan International Instiitute of Technology, Universiti Teknologi Malaysia,Kuala Lumpur, Malaysia

* Correspondence: kamyarshameli@gmail.com, tareq@utm.my
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ABSTRACT

This is a bibliometric analysis study of biodegradable and packaging by studying the documents related to biodegradable field.The use of polymer packaging increased due to its several desired properties such as softness , lightness ans transparency. However , the non biodegradability of polymer packaging only led to a serious ecological problems.Although complete replacement of polymer packaging with biodegradable packaging is quite impossible , still production of biodegradable packaging will reduce the need for synthetic polymer packaging.A lot of studies has been done regarding to the biodegradable and packaging started to attract people from various counties such as China , India and USA. An analysts has been done in this paper by extracting data from WOS database and visualise through VOSviewer to study the collaboration network, topics of interest and impact of publications. Findings reveals that the collaboration work is strong between China and USA as both countries are successful in scientific knowledge technology. This study expected to have an impact for future environment on biodegradable and packaging field.

Keywords:
Biodegradable packaging ,
polymers, mechanical properties,
bibliometric analysis

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1. Introduction

Polymers have become an essential component of modern life due to their wide range of desired qualities and ease of manufacture. Plastics (thermoplastics, thermosets, elastomers, adhesives, coatings and sealants, and PP-fibers) were produced in roughly 348 million tonnes in 2017, and 359 million tonnes in 2018. Asia (51%) is the leading provider, followed by China (30%), Europe (17%), the Middle East and Africa (7%), and others (Europe & EPRO 2019). India is one of the world's biggest

producers and users of plastic. Polyethylene (PE) was the most widely used plastic in India in 2018–2019, with over 15 million tonnes consumed in the form of films and sheets (Aryan et al., 2019).

According to the consumers' point of view, some theoretical adjustments about the relevance of packaging have been developed. Nemat et al. (2019) reviewed the role of food package design in consumer recycling behaviour from a theoretical perspective. Furthermore, Rodrguez-Rojas et al. (2019) used a bibliometric approach to create a packaging bibliometric analysis 1996 through 2016 materials. When these approaches are used, it is conceivable to infer that packaging design necessitates a multidisciplinary approach.Producers, merchants, and consumers are all involved in a conversation and interaction process.(2018, Gustavo et al.). To that end, bibliometric resources will be used in this paper because they allow us to evaluate and analyse academic output across all scientific disciplines, quantifying bibliographic output at various levels and taking into account a variety of agents such as researchers, institutions, and journals (Montero-Daz et al., 2018). According to Cobo et al. (2012), this study has two main goals. First , assess the visibility and influence of scientific production in the studied field. Second, to determine the scientific structure based on research topics in the major topic under investigation, as well as its evolution over time.

This research aims to provide essential information on biodegradable polymers as packaging materials, which is a major discovery that can help reduce the environmental impact of plastic pollution.

2. Materials and Methods

This bibliometric analysis paper data used VOSviewer (version 1.6.16) to analyse and visualize the paper patterns in biodegradable packaging field. The WOS collection database was examined for biodegradable related worldwide literature published between 2012 to 2021. The search keywords used to find the most closely related publication are “Biodegradable And Packaging” which was used in the title. The WOS database provide detail information regarding to the related documents included title, publication date , the publication sorce title and number of citations which can be used for the analysis. Languages and documents type were not restricted throughout the retrieval procedure. The details regarding to related documents consists of publication year , country , document types , research area , WOS categories , publication source titles ,organizations and funding agensies were exported into CSV format. The date of retrieval was on 30th of August 2021. The VOSviewer was used to analyse the data through visualization in term of Co-occurrence , Co-authorship , Bibliographic coupling and Co-citations.

M.M. Kessler came up with the term "bibliographic coupling" in 1963 where two publications have similar references and the strength of the bibliographic coupling increases when there are many references in common (Surwase et al, 2011). In other terms, bibliographic coupling refers to the overlap in published reference lists. Co-citation is the opposite of bibliographic coupling where two publications are cited by third publication. The visualization of bibliographic coupling document, co-citation of cited reference and cited source were determined in this paper. The summary of methodology used in this paper is visualize through figure below (Jose Luis Ruiz Real et al , 2018)

- Searching keywords
  TI=(Biodegradable AND Packaging)
- Export data into CSV format

- Co-occurance by using keyword plus
- Co-authorship for author , organizations and country
- Bibliographic coupling of documents
- Co-citation of cited reference and cited source

Figure 1: Methodology summary for data collections.

3. Results and Discussion

3.1 Literature Publication Growth

The total of paper publication from 2012 until 2021 are 316 papers with average 31 papers were published for each year. The publication of papers in biodegradable field shows an increment and upward trends. There were few studies in biodegradable packaging from 2014 until 2017 with unstable publication which shows lack of interest from researchers to study the biodegradable packaging.Figure 2 shows the graph of publication and citation per year from 2012 until 2021. The bar column indicates the citation per year while the line shows the publication per year. From the graph it is clear that both publication and citation showing an upward trend throughout the year. The maximum publication was recorded in 2020 and 2021, with a total of 63 (15.37 %) documents, while the lowest productivity was noticed in 2012, with a total output of 9 document (2.195%). Due to the recent rise in studies, the number of citations per document was highest for papers published in 2020 with 1,931 citations and lowest for those published in 2012 with 307 citation. In 2020 and 2021, the publications and citations increases eventhough it is pandemic Covid-19 which started at the end of 2019 that affected the academia and researchers.

Researchers from different countries contributed to the publication of documents and from all the publications, there are 10.73, 10.00%, 9.27%, 7.56%, 7.56%,6.83%, 4.63%, and 4.63% from China, India, USA, Italy, Spain , Brazil , Canada and Malaysia respectively. The number of publications from China has increased dramatically in all disciplines, including biodegradable. The top publications countries mostly come from Asia region as the number of researchers has expanded significantly in recent years. Figure 3 shows the bar graph and from the top 10 countries listed, there are 4 countries from Asia which are China, Iran, India and Malaysia. A total of 316 documents were published, the majority of documents are in article form with 73.42%. The growth of article shows the knowledge of biodegradable packaging increases and initiate new knowledge and problem solving in this field. By using the article information, the awareness of biodegradable packaging increases in the public and can disprove any misunderstanding with proven research. Proceeding papers were the second most prevalent form of paper, accounting for 15.12% of all documents. The details regarding to type of

documents are shown in Figure 4. All of the documents were published 98.29% in English based on the data obtained from Web of Science. The documents that published in English can reach more people and the documents can be globally recognized.

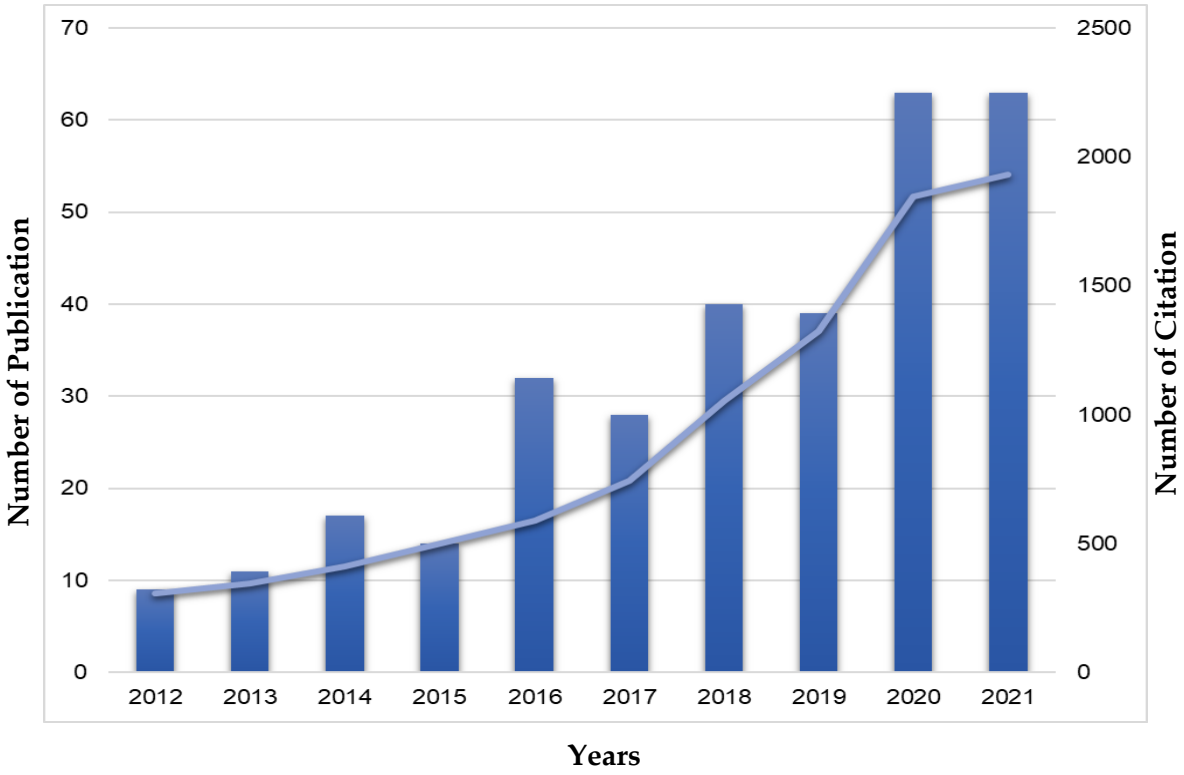

Figure 2: Graph of Publications And Citations Per Year.

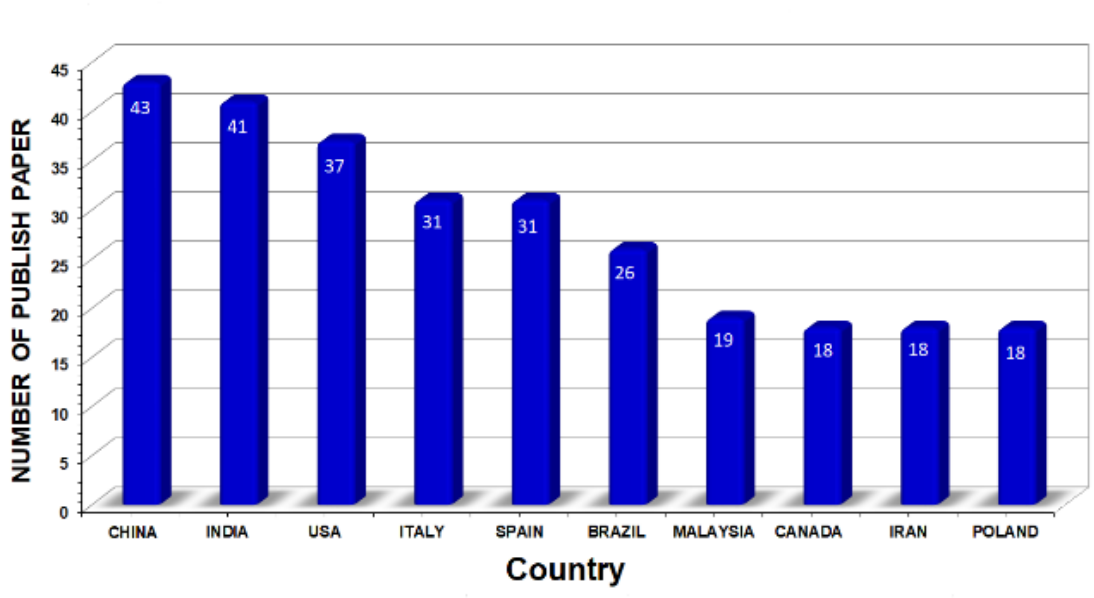

Figure 3: Graph of number of published papers based on country.

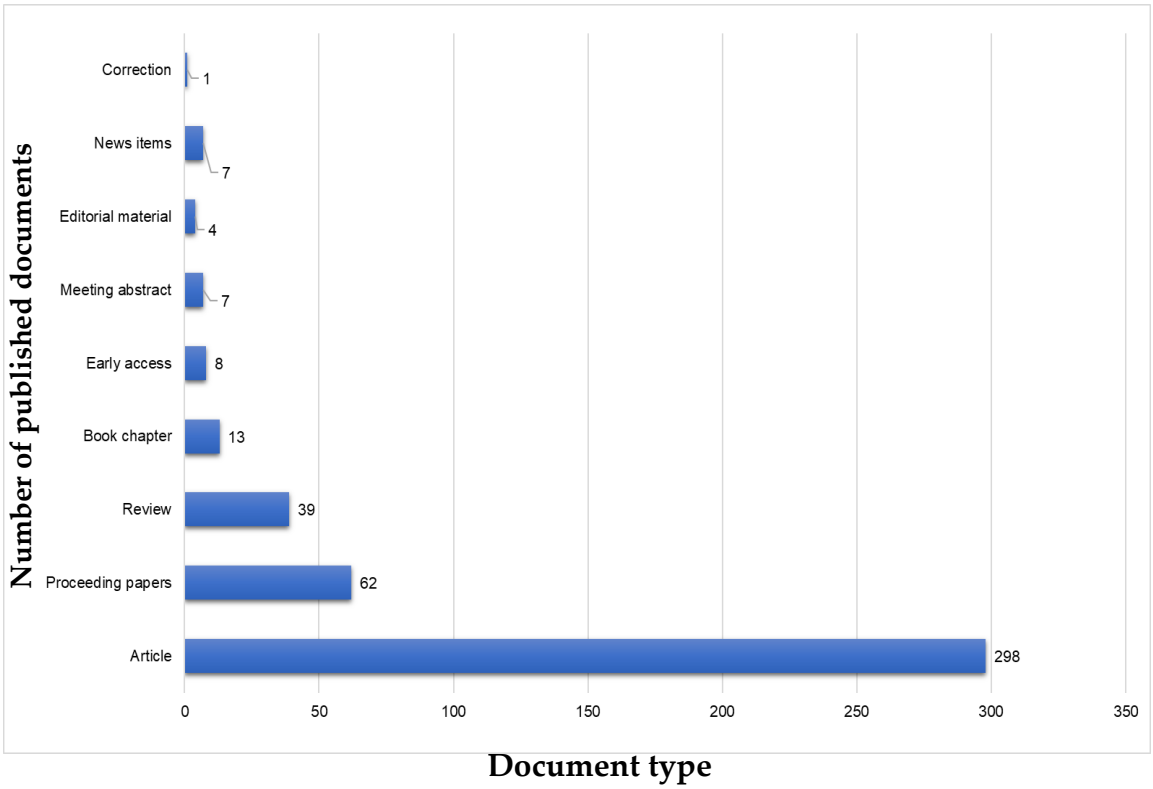

Figure 4: Graph of document type.

3.2 Paper Publication

The publication that has the highest amounts of published documents is Food Packaging and Shelf Life with 21 documents (5.12%). The journal produces high-quality research publications on a wide range of delivery science and technology topics .Thus, the number of published documents in Food Packaging and Shelf Life is highest as biodegradable plastics are mostly used in food industries. The second highest published record is Journal of Applied Polymer Sciences with 16 documents (3.9%). The details of publication (source title) with the publication records are shown in Figure 5.

The classification of research area based on Web of Science categories shows that Food Science Technology is the highest category with 136 documents. The second highest is Polymer science which consists of 115 documents in this area. The data regarding to Web of Science categories is illustrated in Figure 6. The contribution of an organization with the highest published document is by Michigan State University with 10 total documents. Based on the Figure 7 there are 3 organizations from Italy and 3 organizations is from United State and total of 4 organization from Asia. The organizations from Italy are University Catania with 5 documents, University Salerno with 8 documents and CNR with 9 documents. There are total of 22 published documents from Italy. The other organizations from Asia are University Science Malaysia and University Putra Malaysia from Malaysia which contributes 14 published documents in biodegradable polymers . Kasetsart University, Thailand and Gorgan University agriculture Science Natural Resources, Iran have published 5 and 5 published documents respectively that leads to increment of publication documents in Asia regions. From the data, it is clearly shown the ability of Asia people in doing the research about biodegradable polymers. The second highest organization is CNR from Italy with 9 published documents.

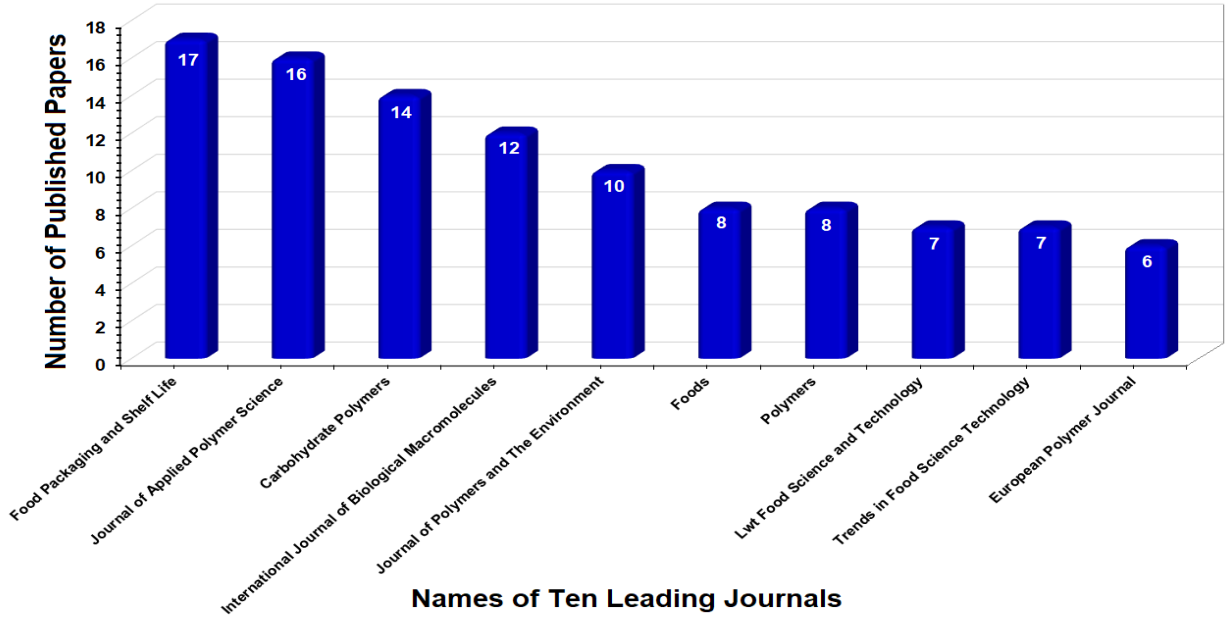

Figure 5: Graph of Source title.

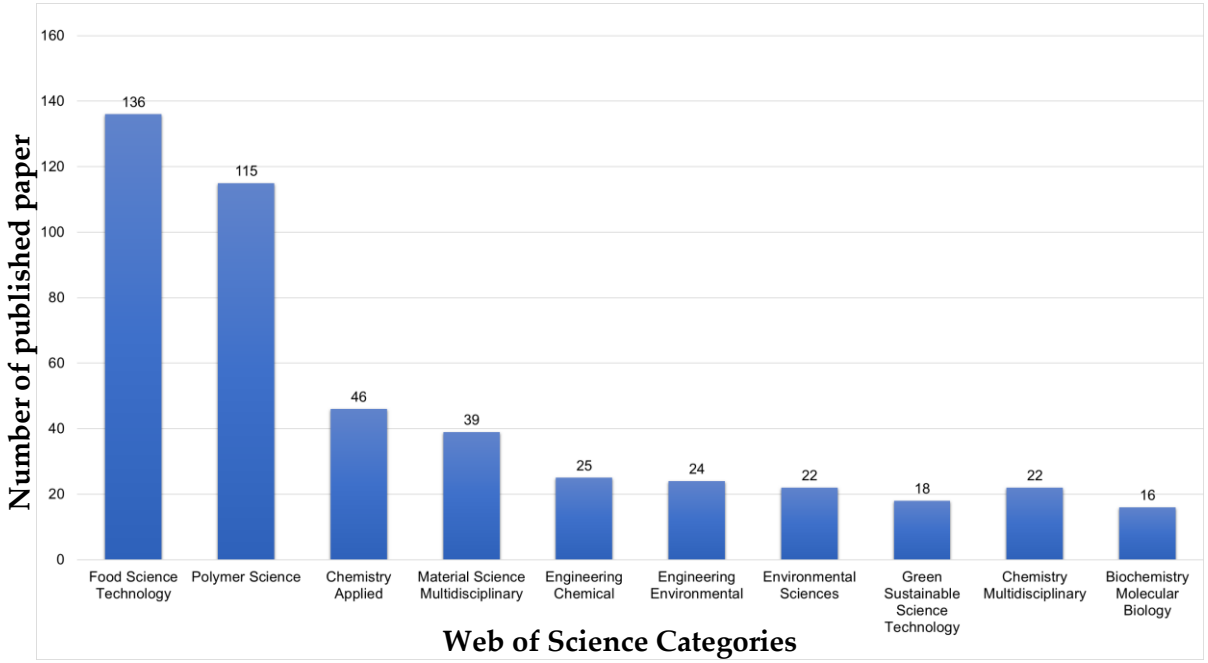

Figure 6: Graph of web of science category.

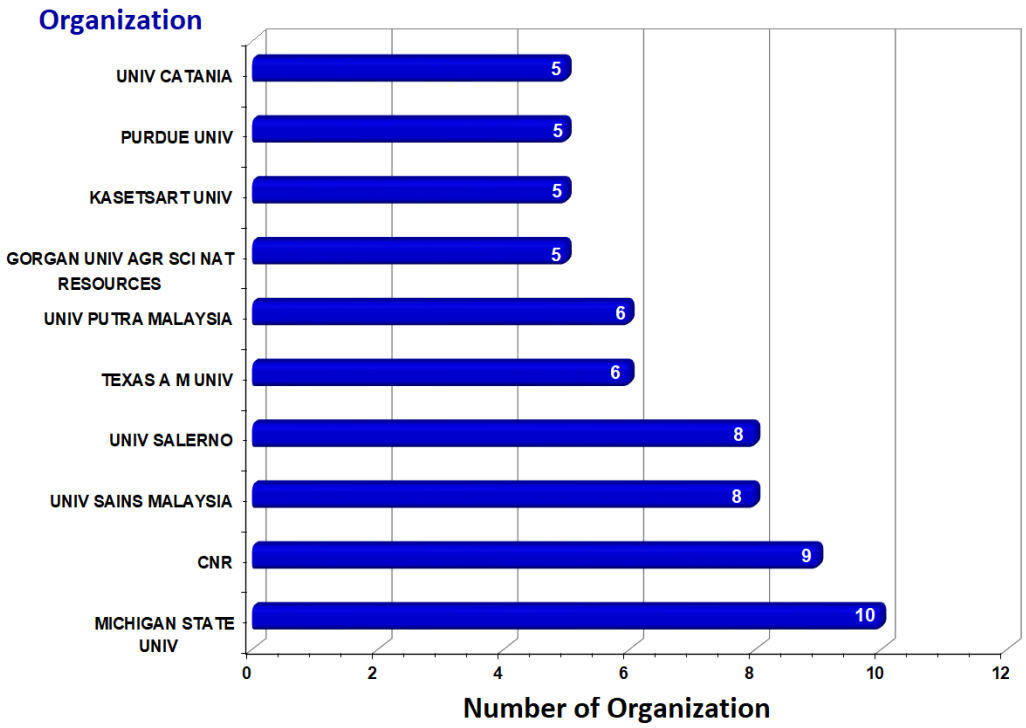

Figure 7: Graph of organizations.

3.3 Bibliometric Analysis of Keyword

Keywords submitted by the paper's authors that appeared more than 10 times in the Web of Science core database were included in the final analysis. There are 38 words met threshold out of 900 keywords. The keyword that appeared the most in the documents were "Mechanical properties" (203 total link strength) with 75 occurrence and "films" (81 total link strength) with 46 occurrences. The keyword "mechanical properties" is found the most as biodegradable packaging is one of polymer properties and instead of that it is also related to keyword "barrier properties" (115link strength) and toward "edible films" with 46 link strength. This can be explained as the biodegradable is design to become responsive stimulus especially toward properties changes. Overall, the map of keywords has 3 clusters and can be referred to Figure 8. The size of nodes indicates the occurrence frequency while the curve shows the co-occurrence in the same publication. The shorter the distance of two nodes shows larger number of co-occurrences between the keywords.

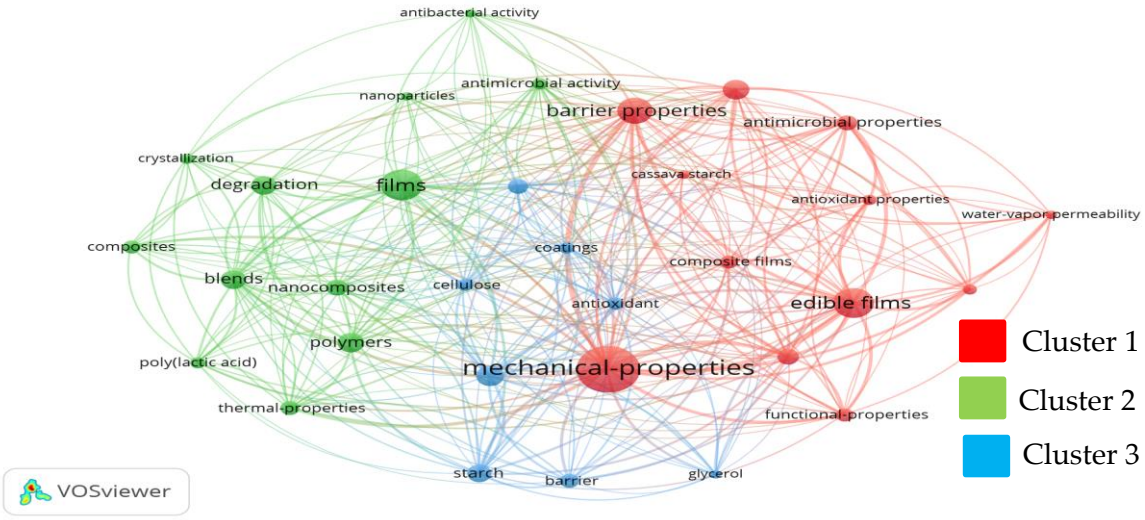

Figure 8: Analysis of keywords.

3.4 Bibliometric Analysis of Co-authorship

In total, 1,583 writers contributed to the publishing of the biodegradable packaging documents and with minimum 2 numbers of documents per author, there are 138 authors that met the threshold. From the result, Arvanitoyannis,I from University Of Thessaly, Volos as published 6 documents. The main collaborator of Aryanitoyannis is Yamamoto,n and Nikolaou,e . The total link strength is 38. Based on Figure 9, it shows that the collaborations are mostly from Greece to produce related documents of biodegradable packaging. The map of co-authorship of author shows 2 clusters in total.

Through the global literature search, there are 524 organizations contributes in publishment of related documents regarding to biodegradable packaging and about 45 organizations have published with 3 minimum number of documents per organizations. The total clusters observed are 2 clusters. The visualization by observed 1 clusters that shown as in Figure 10 where Michigan State University in red cluster has the biggest size of circle with 10 documents. From the figure, organization from United State tends to collaborate with the organization from their own country.

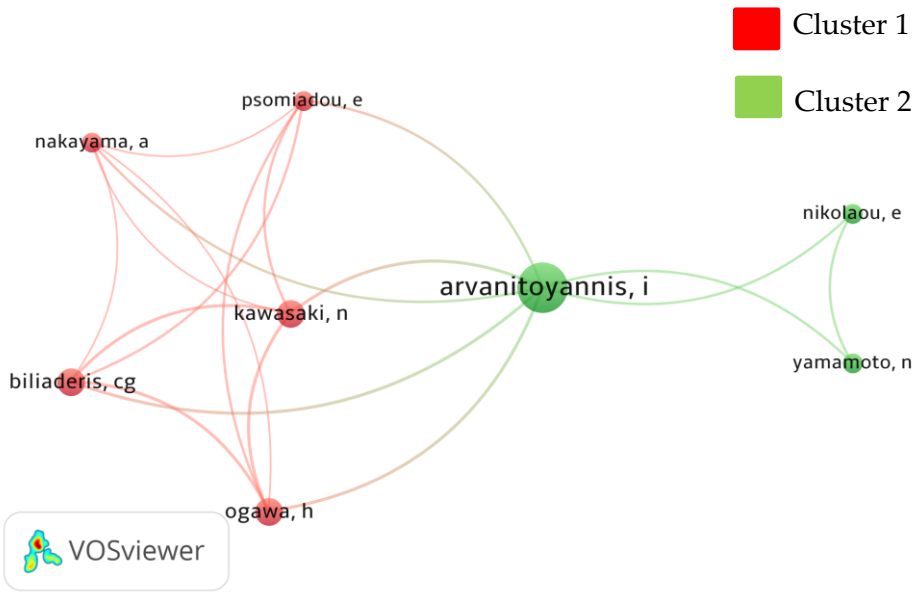

Figure 9: Analysis of co-authorship of author.

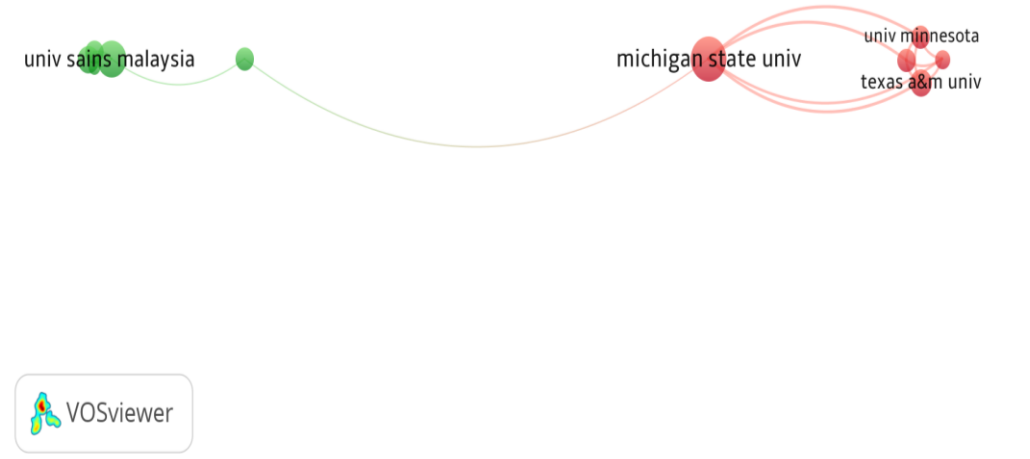

Figure 10: Analysis of co-authorship of organizations.

3.5 Bibliometric Analysis of Bibliographic Coupling and Co-citation

Bibliographic coupling is when two publications been cited by third publications while co-citation is pairs of publications that are cited together in the source articles are tracked. The bibliographic documents are shown in Figure 11 and co-citation of cited author in Figure 12. six clusters are obtained in bibliographic coupling and167 documents met the threshold with 11 minimum number of citations per document. Cluster 1 shown in red includes 27 items . Cluster 5 that shown in purple consisted Siracusa collaborate with Valentina , Rocculi, Pietro , Romani, Santina,

Dalla Rosa , Marco to publish biodegradable polymers for food packaging review paper. Figure 12 shows the description of each cluster and the number of documents related within the cluster.

The co-citation of cited reference consists of 4 clusters from the analysis with 11 minimum citations of a cited reference. The 4 clusters represent four different research field that shown in the colour of red, green, blue and yellow. The biggest clusters of cited references include 8 items .The two biggest cited source clusters consist of 19 and 11 items, respectively. The representative journals are Food Hydrocolloid and carbohydrate polymer as shown in Figure 13. Food Hydrocolloid is in red cluster while carbohydrate polymer is in green cluster. This journal shows a high impact as the number of citations is highest and linked with 435 other sources.

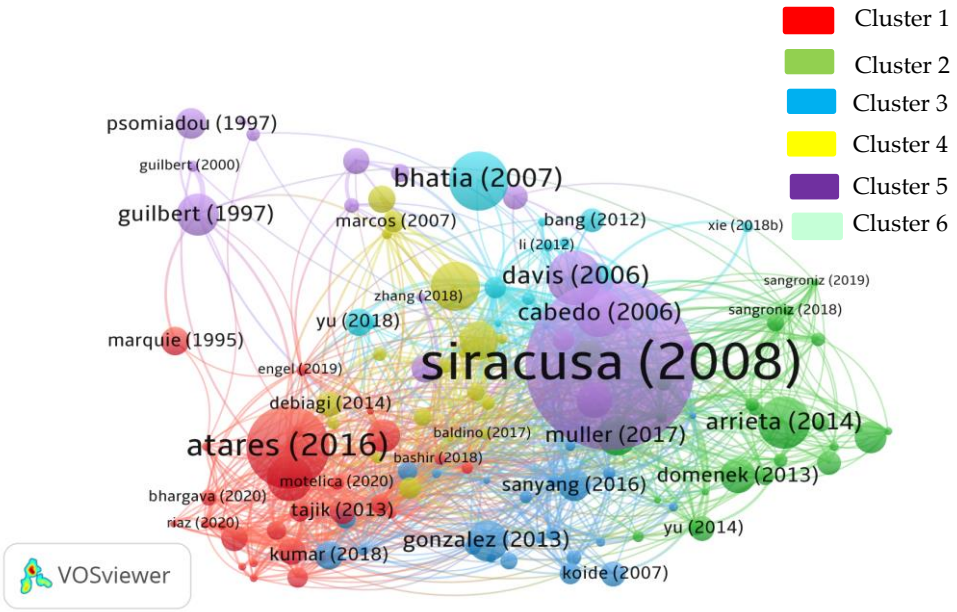

Figure 11: Analysis of bibliographic coupling of documents.

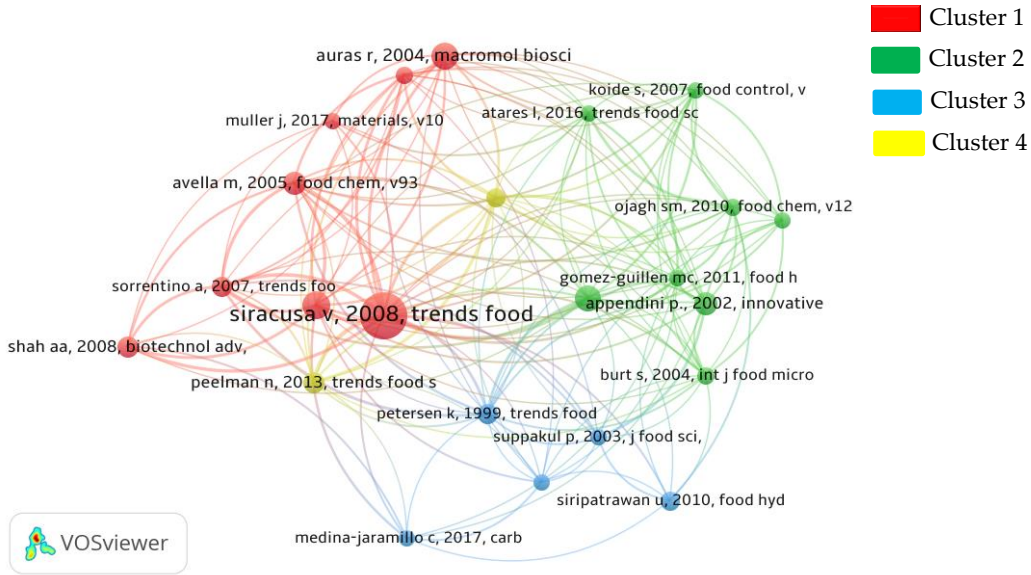

Figure 12: Analysis of Co-cited of cited reference.

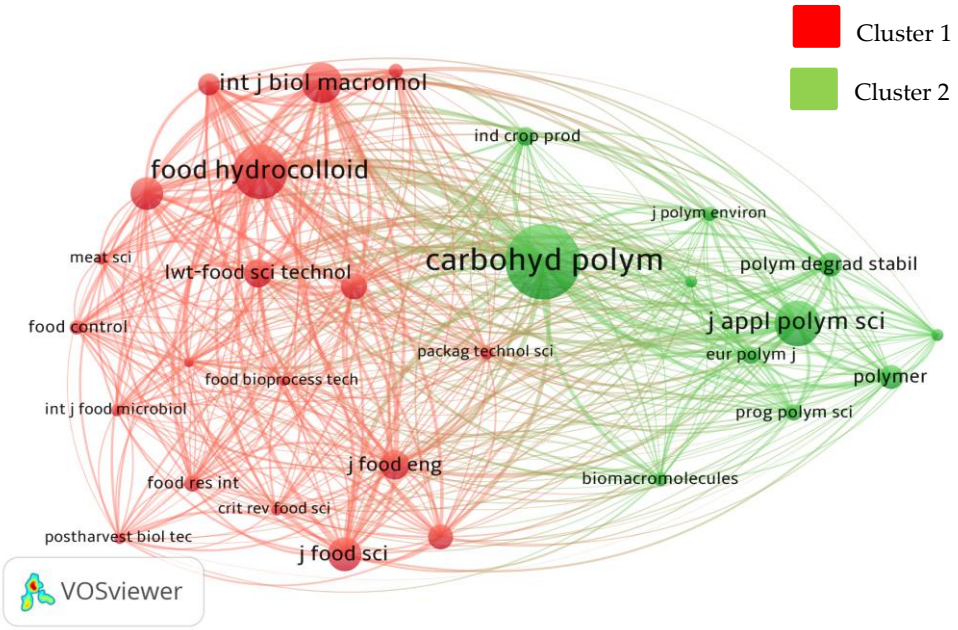

Figure 13: Analysis of co-citation of sources.

4. Conclusions

The bibliometric analysis of biodegradable packaging were discussed by the data extracted from WOS database and visualization of VOSviewer. This study demonstrated the pattern of biodegradable field throughout the year from 2012 until 2021to better understand this field globally. The study is one of the few that integrate co-occurrence, co-authorship, and co-citation analyses to better understand the evolution of biodegradable packaging from many points of view. The growth of publication shows good increment where the study of biodegradable polymers is apply through the application in food packaging. As we know ,the Covid-19 pandemic affect some researchers and academia in handling new research. Eventhough its effect some research , it shows good improvement in biodegradable polymer research. From the analysis result, we can observe that the number of publications increases starting from 2020 until 2021. This study able to display the visualization of biodegradable packaging and analyse the result obtained. China is the highest publication in biodegradable field with 43 documents which successfully put their authors in the top 10 globally. Most of the papers are from Asia which shows the increase of researchers in this region including Iran , India and Malaysia. The finding through VOS viewer can shows the collaboration that occur between author and country. High impact paper can be published in the biodegradable packaging or biodegradable polymers field. China also is one of the biggest contributors in biodegradable research to keep up with international pace of progress. It is also shown where most the author in biodegradable field from China able to produce more papers and listed in the top 10 authors. In the bibliographic coupling and co-citation, the research area for each cluster can be observed. Most of the article tends to study biodegradable packaging to improve a friendly environment. From this analysis, the objectives to analyse and determine the collaboration network, topic of interest and impact of publications in biodegradable packaging study are achieved. The future research can develop new study of biodegradable packaging through this analysis. The method for the analysis and study are available to be tested with other biodegradable field. There is

still limitation where there is effort to generalize the research area for each cluster as there are 316 documents collected in WOS database. Nevertheless, this study can be useful for the bibliometric path of the future study.

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References

1. J. L. Ruiz-Real, J. Uribe-Toril, J. D. P. Valenciano, J. C. Gázquez-Abad. Worldwide research on circular economy and environment: A bibliometric analysisint. (2018), *J. Environ. Res. Public Health*, 15, 2699; 1-14. doi:10.3390/ijerph15122699.
2. Y. Aryan, P. Yadav, S.R. Samadder. (2019), Life Cycle Assessment of the existing and proposed plastic waste management options in India: A case study. *J. Clean. Prod*., 211, 1268−1283. doi:10.1016/J.JCLEPRO.2018.11.236.
3. B. Nemat, M. Razzaghi, K. Bolton, K. Rousta, (2019), The role of food packaging design in consumer recycling behaviour: A literature review, *Sustainability*, 11(16), 4350. doi: 10.3390/su11164350.
4. A. Rodrıguez-Rojas, A.A. Ospina, P. Rodrıguez-Velez, R. Arana-Florez, (2019), What is the new about food packaging material: A bibliometric review during. 1996–2016, *Trends in Food Science and Technology*, 85, 252−261.
5. J.U. Jr. Gustavo, G.M. Pereira, A.J. Bond, C.V. Viegas, M. Borchardt, (2018), Drivers, opportunities and barriers for a retailer in the pursuit of more sustainable packaging redesign, *Journal of Cleaner Production*, 187, 18−28. doi:10.1016/J.JCLEPRO.2018.03.197.
6. Montero-Dıaz, J., Cobo, M.J., Gutierrez-Salcedo, M., Segado-Boj, F. and Herrera-Viedma, E. (2018), "Mapeo cientıfico de la categoria «comunicacion» en WoS (1980-2013)", *Comunicar*, 26(55), 81−91.
7. M.J. Cobo, A.G. Lopez-Herrera, E. Herrera-Viedma, Herrera, F. (2012), SciMAT: A new science mapping analysis software tool, *Journal of the American Society for Information Science and Technology*, 63(8), 1609−1630. doi.org/10.1002/asi.22688
8. https://www.desjardin.fr/en/blog/what-is-biodegradable-packaging
9. I, Anita, Z. Karlo, T. Stanislava, B. anita, L. Marija. (2017), Biodegradable packaging in the food industry. *Archiv Für Lebensmittelhygiene*, 68(3):23−52.
10. I. Majid, M. Thakur, V. Nanda, (2018), Biodegradable Packaging Materials. *Reference Module in Materials Science and Materials Engineering*, 1993 (2000), 111. doi: 10.1016/b978-0-12-803581-8.10356-x
11. S. Shaikh, M. Yaqoob, P. Aggarwal, (2021), An overview of biodegradable packaging in food industry. *Curr. Res. Nutr. Food Sci.* 4, 503–520. doi: 10.1016/j.crfs.2021.07.005

A. Ivankovic, K. Zeljko, S. Talic, A.M. Bevanda, M. Lasic. (2017), Biodegradable packaging in the food industry. *Archiv Für Lebensmittelhygiene*.

12. L. Motelica, D. Ficai, A. Ficai, O.C. Oprea, D.A. Kaya, E. Andronescu, (2020), Biodegradable antimicrobial food packaging: Trends and perspectives. *Food*, 9(10), 1438, 1–36. doi.org/10.3390/foods9101438.
13. A. Diaz-Ruiz, U. Orbe-Arteaga, C. Rios, E. Roldan-Valadez, (2018), Alternative bibliometrics from the web of knowledge surpasses the impact factor in a two-year ahead annual citation calculation: linear mixed-design models' analysis of neuroscience journals", *Neurology India*, 66(1), 96-104. doi: 10.4103/0028-3886.222880.
14. M. Ozdemir, J.D. Floros, (2004), Active food packaging technologies, *Critical Reviews in Food Science and Nutrition*, 44(3), 185–193. doi: 10.1080/10408690490441578.
15. C. Silvestre, D. Duraccio, S. Cimmino, (2011), Food packaging based on polymer nanomaterials, *Progress in Polymer Science*, 36(12), 1766–1782. doi:10.1016/j.progpolymsci.2011.02.003.
16. J.L. Ruiz-Real, J. Uribe-Toril, J.D.P. Valenciano, J.C. Gázquez-Abad. (2018), Worldwide Research on Circular Economy and Environment: A Bibliometric Analysis. *Int. J. Environ. Res.* 15(12), 2699. doi:10.3390/ijerph15122699.
17. Visualizing freely available citation data using VOSviewer, Nees Jan van Eck, Ludo Waltman October 23rd, 2017.
18. D.C.P. Ambrose. (2019), Biodegradable Packaging: An Eco-Friendly Approach. *Curr. Agri. Res.* 2020;8:4–6. doi: 10.12944/CARJ.8.1.02.
19. A. Ivanković, Z. Karlo, T. Stanislava, B. Anita, L. Marija. (2017), Review: Biodegradable packaging in the food industry. *Arch. Food Hyg.* 68, 26–38. doi: 10.2376/0003-925X-68-26.
20. P. Mona, M. Amalia, P. Niculita, G. Mihaela, G. Mihaela, T. Mira. Biodegradable Materials for Food Packaging Applications. *J. Environ. Prot. Ecol.* 2011, 12, 1825–1834.
21. P.A. Pawar, A.H. Purwar. Biodegradable Polymers in Food Packaging. *American Journal of Engineering Research*, 2013 2(5): 151–164.
22. S. Farrisa, K.M. Schaich, L.S. Liu, L. Piergiovanni, K. Yamab, (2009), Development of polyion-complex hydrogels as an alternative approach for the production of bio-based polymersfor food packaging applications, *Trends Food Sci. Technol*., 20, 316–332. doi: 10.1016/j.tifs.2009.04.003.
23. V. Siracusa, P. Rocculi, S. Romani, M. D. Rosa, (2008), Biodegradable polymers for food packaging: a review. *Trends Food Sci. Technol.*, 19, 634-643. doi:10.1016/j.tifs.2008.07.003
24. J. Muller, C. González-Martínez, and A. Chiralt, "Combination of poly (lactic) acid and starch for biodegradable food packaging" *Materials*, 10(8), 952, 2017. doi: 10.3390/ma10080952.
25. J. Jeevahan, M. Chandrasekaran, R. Durairaj, G. Mageshwaran, and G. B. Joseph, (2017), A brief review on edible food packing materials," *Journal of Global Engineering Problems and Solutions*, 1(1), 9–19.
26. S. Mangaraj, A. Yadav, L. M. Bal, S. K. Dash, and N. K. Mahanti, "Application of Biodegradable Polymers in Food Packaging Industry: A Comprehensive Review," *Journal of Packaging Technology and Research*, 3(1), 77–96, 2019. doi: 10.1007/s41783-018-0049-y.

27. H. Chbib, M. Faisal, A. El Husseiny, I. Fa, and N. ME, (2019), The future of biodegradable plastics from an environmental and business perspective," *Modern Approaches on Material Science*, 1(2), 2019. doi: 10.32474/MAMS.2019.01.000109.
28. B. Khan, M. B. K. Niazi, G. Samin, and Z. Jahan, (2017), Thermoplastic starch: a possible biodegradable food packaging material—A review," *Journal of Food Process Engineering*, 40(3), 12447. doi: 10.1111/jfpe.12447.
29. W.K. Xin, Y. K. Sen, S. D. Rajendran, (2019), A study on the benefits of eco-friendly packaging on sustainable supply chain management in fast moving consumer goods industry. E3S Web of Conferences 136, 4092, 1-7. doi: 10.1051/e3sconf/2019136040
30. A. Marques, S.M.D. Luz, (2021), Use of biodegradable polymer for development of environmental tracers: A bibliometric review. *Polímeros*, 31(1), 1–14. doi: 10.1590/0104-1428.00221.