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Bibliometric Analysis of Nano-Sized Agricultural Waste Brake Pads Research During 2018-2022 Using VOSviewer

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Abstract

The agricultural brake pad is one solution to reduce the danger of using asbestos in-vehicle systems. This research aims to conduct bibliometric analysis in nano-sized agricultural waste brake pads by combining mapping analysis using VOSviewer software. Application reference manager used to obtain research data. The data received results from a search based on the keyword "Brake pads, Nano-sized, Agricultural waste." The search results found 1000 relevant published articles in 2018-2022. The results showed that research on nano-sized agricultural waste brake pads has been increasing through the year, and research continues with a high number of publications in early 2022. This study demonstrates the importance of bibliometric analysis in analyzing data on what phenomena happen. This research is expected to help and become a reference for researchers in conducting and determining the research themes.

Keywords

Agricultural waste; Brake pads; Bibliometric; VOSviewer; Data analysis.

1 Introduction

Braking systems of vehicles have two essential parts: the disc and pad pair. Brake pads control speed by converting kinetic energy into heat energy radiating to the atmosphere in brake systems of vehicles and speed-controlled machines. The vehicles have two brake systems, disc brake and drum brake [1]. Disc brake systems have been widely used in recent years because they have better braking performance [2]. The pads used in brake systems provide braking by rubbing against the disc or drum surface [3].

Fibers are generally used to provide strength and control brake composites' wear and friction properties. In addition, the fibrous reinforcement also helps suppress the inherent compositional deficiencies resulting from the selection of the wrong material [4]. Natural fiber materials used are the stems, bark, seeds, and leaves [5]. Fibers in biomass are one of the current trend materials used for asbestos-free brake pads or non-asbestos organic material (NAO) research as a source of raw materials for composite development [1], [3], [6]–[8]. Fibers also have great potential as composite materials because of their high strength, low cost, eco-friendly nature, availability, and sustainability [6], yet there are still some troublesome issues, such as human and environment-friendly nature, cost, and unsteady performance must be settled [8].

Recent international environmental efforts to address the problem and meet the need to protect the environment have attracted research focus on the use of natural fibers in several applications, including brake pads. Typically, brake pads contain asbestos embedded in a polymer matrix with some other material. However, its use is gradually being avoided due to its carcinogenic effects on human health and other harmful properties. In addition, new non-asbestos materials and brake pads are being developed [5], [6], [8]–[12].

Bibliometrics is a statistical method that could quantitatively analyze the research papers concerned about one special topic via mathematical ways. It could also assess the quality of the studies, analysis the key areas of research, and predict the direction of future studies. Google Scholar (*Google Cendekia*) provides a simple way to broadly search for scholarly literature. Search across a wide variety of disciplines and sources: articles, theses, books, abstracts, and court opinions which also provides built-in analysis tools to produce representative figures. What is more, the search results from WOS could be exported to software for further analysis like VOSviewer. [13], [14].

Based on our previous studies relating to bibliometric [14]–[19], this study aims to conduct nano-sized agricultural waste brake pads by combining mapping analysis using VOSviewer software. This research is

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expected to help and become a reference for researchers in conducting and determining the research topic to be taken, especially those related to the field of nano-sized agricultural waste brake pads.

1.1 Current studies in the preparation of brake pads using agricultural wastes

Table 1 shows the current detailed study in the preparation of brake pads using agricultural waste as reinforcement components. The table shows the types of agricultural waste, supporting components, and the results obtained from the research. Agricultural waste in question can come from plants, animals, or other agricultural-livestock waste. Significant results have been obtained from the study, which means that agricultural waste has the potential to replace hazardous materials for brake pads.

2 Method

The article data used in this research is research data from articles that have been published in journals that have been indexed by Google Scholar. In this study, we used Google Scholar because Google Scholar can be accessed for free, in contrast to Scopus, which cannot be accessed freely by readers. Indeed, we would use the Scopus database in our future research. Reference managers' application was used to obtain research data. The reference managers application used in this research is Publish or Perish. Publish or Perish was used in conducting a literature review of the theme that we would take. Every article data must be indexed by Google Scholar and in the type of journal articles and having conformity with the search for the themes needed in this study are backed up into a file that is used in the use of VOSviewer. Detailed information regarding VOSviewer and library quest is explained in our previous studies [14]

In this study, each article was filtered, and we took only articles relating to Brake pads. We search for data on Publish or Perish by entering the keyword "Brake pads, Nano-sized, Agricultural waste" according to the title, keyword, and abstract criteria. Thus, 1000 articles were obtained, which were assessed according to the chosen topic. The articles used in this study were articles published in the 2018-2022 range. The collected articles were then saved in *.ris format. Next, we used the VOSviewer application to visualize and analyze trends in the form of bibliometric maps. We did data mapping articles from database sources that have been prepared. Data mapping consists of three types, namely network, density, and overlay visualization. In addition, we also filtered the terms that would be included in the VOSviewer network mapping visualization.

3 Results and Discussion

3.1 Research developments in the field of nano-sized agricultural waste brake pads

Figure 1 shows a curve of the growth or development of research on nano-sized agricultural waste brake pads from 2018 to 2022. Based on Figure 1, the development of research on nano-sized agricultural waste brake pads over the last five years, namely from 2018-to 2022, has been increasing over the years. This shows that the phenomenon of the Coronavirus disease (Covid-19) pandemic has not prevented researchers from developing nano-sized agricultural waste brake pads. Research continues with a high number of publications in early 2022 of 44 articles.

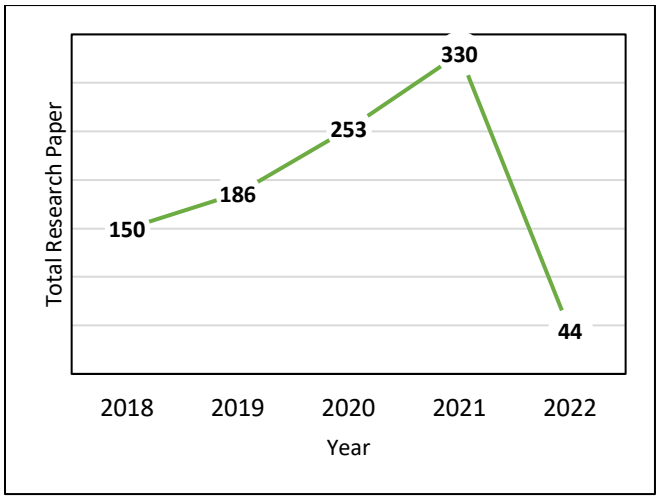

Figure 1 Level of development of research on nano-sized agricultural waste brake pads

3.2 Visualization nano-sized agricultural waste brake pads topic area using VOSviewer

According to Bayu et al., 2021, the minimum number of relationships between terms in the VOSviewer is regulated by ten terms. Research related to nano-sized agricultural waste brake pads based on analysis mapping visualization is divided into 6 clusters, namely:

Cluster 1 has 19 items there are addition, agricultural land, field, formation, generation, heavy metal, morphology, municipal waste, nanomaterial, nanotechnology, plastic waste, present study, role, shape, surface, synthesis, waste management, wear, and wide range.

Table 1 Current studies in the preparation of brake pads using agricultural wastes as a reinforcement component adaptation from table 1 [10]

Type of Agricultural Waste	Supporting components	Result	Ref.
		PLANT	
Banana Peels	Phenolic resin	Increases in the number of banana peels attributed to high compressive strength, high hardness value, high specific gravity, low wear rate, low water absorption, and low water absorption	[7]
Banana Tree Bark Powder	Phenolic resin	Banana and supporting components have a positive effect on the friction coefficient of the pad, but less stability friction than banana peels with the same supporting component reduced the hardness increased the density.	[1]
Banana peels powder carbonized	Phenolic resin	Increasing compressive strength, hardness, and specific gravity of the produced samples in wt% resin addition gave the better properties in all. Proper bonding was achieved,	[11]
Banana Fiber	Phenolic resin, Barium Sulphate	the highest coefficient of friction, least frictional fluctuations with lowest fade-% compared to the other investigated composites. On the other hand, the wear performance of the composites decreased whereas recovery-% increased with increasing banana fiber and decreasing barium sulfate content.	[8]
Sawdust	Slag waste, epoxy resin, silicon carbide, and graphite.	The addition of Sawdust had an impact on the wear rate and degradability of the brake pad. The high amount of Sawdust has high ash content, low density, low compressive strength, and high degradability/wear rate. Large SD particle size is attributed to increases in porosity and wear rate.	[10]
Palm kernel shell	Epoxy resin, hardener, and cow bone	Increases in Palm kernel shell particle size attributed to low density, high impact strength, low hardness value, low water resistance, and low oil resistance.	[10]
Palm Ash	Epoxy resin, polychlorinated biphenyls (PCB), and metal filler	The higher percentage of palm ash resulted in the obtainment of the best mechanical and wore properties.	[20]
Periwinkle shell	Phenolic resin (phenol-formaldehyde)	Decreases in PS's particle size are attributed to the high wear rate and high friction coefficient.	[21]
Bagasse	Phenolic resin (phenol-formaldehyde)	Decreases in Bagasse particle size attributed to better particle distribution, high compressive strength, high density, high water resistance, high oil absorption, high flame resistance, and low wear rate.	[22]
Coconut shell	Epoxy resin	Decreases in the amount of Coconut shell correlated to high breaking strength, hardness, compressive strength, and impact strength.	[6]
Maize husk fiber	Epoxy resin, hardener, maize husk, silica iron oxide, calcium carbonate, and powdered graphite	A high amount of Maize husk fiber correlated to high density, coefficient of friction, water absorption, and oil absorption. However, a high amount of MHF decreased hardness, wear rate, tensile strength, compressive strength, and thermal conductivity.	[6], [23]
Snail shell	Phenolic resin, rubber seed husk, catalyst, and accelerator.	Increases in the Snail shell's particle size contributed to high oil absorption, high water absorption, high wear rate, low compressive strength/hardness, and low density.	[24]
Groundnut shell	Phenolic resin	Increases in Groundnut shell attributed to high oil absorption, water absorption, density, and compressive strength. Large Groundnut shell particles improved the compressive strength.	[9]
Corn Husks	Silicon carbide, graphite, resin, and steel dusk	The corn husk (100 μm) gave the finer distribution of the corn husk particle in the matrix. The corn husks resulted in the obtainment of the brake pads with better compressive strength, lower porosity, higher hardness, and a lower rate of brake pad wear.	[25]
Water Hyacinth (*Eichhornia crassipes*)	Phenolic resin	The brake pads with fiber from Eichhornia crassipes showed less acetone extraction value, had plateau formation, and good fiber bounding	[26]
Cashew nuts	Epoxy resin, iron oxide, nano hematite Nano Talc, and Nano silicon oxide are milled from white sandstone.	Cashew nuts could make the brake pads have high limit friction, good resistance to oil and water absorption, high tensile and compression properties, and good thermal stability.	[27]
Miscanthus sp.	Cashew, alumina, calcite, and phenolic resin	The addition of Miscanthus sp. on the brake pad affected the density and porosity, which was also a function of the mixture proportion of material, curing time, and curing temperature.	[28]
Cocoa beans shells	Calcium carbonate, silica sand, anhydrous	The brake pads with 60% of epoxy resin and 21% of cocoa beans shells gave the optimum performance compared to the asbestos-based brake pad in terms of friction coefficient, tensile strength, compressive strength, and hardness.	[29]

Type of Agricultural Waste	Supporting components	Result	Ref.
	iron oxide, epoxy resin, and graphite.		
Lemon peels	Epoxy resin, aluminum oxide, graphite, iron oxide, and calcium hydroxide	The brake pad with a density of 1.55–2.00 g/cm3, hardness of 26–32 (barcol hardness), percentage wear loss of 13.45–19.14%, percentage water loss of 0.96 – 1.38%, oil absorption of 0.01– 0.02%, and wear of 13.45–19.14% was obtained when using lemon peels, which is better than commercial brake pads	[30]
		Animals	
Seashell (The shells of sea snails)	Epoxy resin, graphite, and aluminum oxide	The brake pad made from seashells showed good mechanical and tribological properties, including good compressive strength, hardness, flexural, and impact strength.	[31]
Cow bone	Unsaturated polyester resin, methyl ethyl ketone peroxide (MEKP), polyvinyl acetate, 2% cobalt solution, and ethanol.	The brake pads reinforced with cow bones (sizes of 75 μm) gave a better tensile strength than other polyester matrices, while the sizes of 300 μm gave the optimal hardness result. The addition of cow bone also improved flexural strength.	[32]
Cow hooves	Graphite, aluminum oxide, barium sulfate, and epoxy resin.	The results showed that a sample composed of 15% pulverized cow hooves, 35% epoxy resin, and a sample with 10% pulverized cow hooves and 7% epoxy resin gave the optimum results when compared with commercially asbestos brake pads. The cow hooves brake pads gave good mechanical, tribological, and physical properties	[33]
		Other	
Fly ash	Phenolic resin, Rockwool, ceramic wool, zirconium silicate (zircon), and calcium hydroxide	The hard fibers in fly ash improved the tensile strength and hardness of the friction material. The friction test was in the range between 0.35 and 0.48, which is better than barites-based (without fly–ash) and asbestos-based brake pads.	[34]

Cluster 2 has 18 items there are an agricultural waste product, approach, asbestos, biocomposite, biopolymer, brake lining, brake pads, characterization, composite, comprehensive review, fiber, filler, fabrication, natural fiber, pad, polymer composite, sustainability, and tribological property.

Cluster 3 has 14 items there are agro, agro-industrial, waste, agro waste, aluminum, aluminum matrix composite, ash, diameter, mechanical, mechanical property, reinforcement, rice husk, rice husk ash, tribological behavior, and waste material.

Cluster 4 has 12 items there are blend, brake, brake power, thermal brake efficiency, diesel engine, efficiency, experimental investigation, impact, increase, nano additive, nanoparticle, and performance.

Cluster 5 has seven items there are agricultural waste material, automobile, cellulose, composite material, nitrocellulose, nanocomposite, and sugarcane bagasse. Cluster 6 has two items there are copper and friction.

Cluster 1 is marked in red, cluster 2 is marked in green, cluster 3 is marked in dark blue, cluster 4 is marked in yellow, cluster 5 is marked in purple, and cluster 6 is marked in light blue.

3.3 Network visualization of nano-sized agricultural waste brake pads keyword.

The visualization network will display the network between the visualized terms [14], [15], [17]–[19]. Figure 2 shows the relationship between terms. The relationships in network visualization are depicted in a network or line that comes from one term to another. Figure 2 shows the clusters in each of the researched topic areas.

In Figure 2, the Brake pad is included in cluster 2 with a totaling strength of 2671 and an occurrence of 72. Brake pads are connected to cluster 1, namely term nanotechnology, cluster 3, and cluster 4, namely term agro waste.

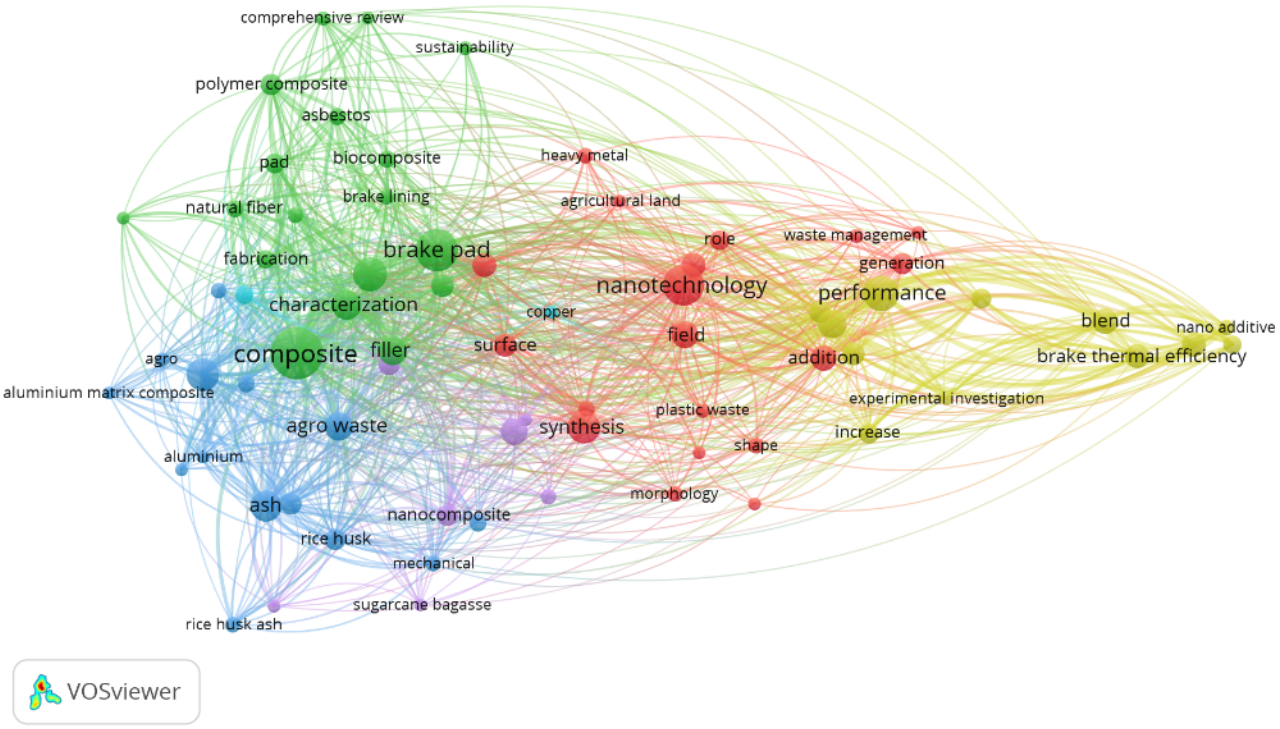

Figure 2. Network visualization of nano-sized agricultural waste brake pads keyword

4 Conclusion

This study aims to conduct bibliometric research in nano-sized agricultural waste brake pads by combining mapping analysis using VOSviewer software. Publish or Perish is a references manager application used to collect data in this research. The data obtained is the result of filtering based on the keyword "Brake pads, Nano-sized, Agricultural waste." The bibliographic data used in this study concerns the topic areas, titles, keywords, and abstracts. From the search results, we obtained 1000 relevant articles published in the range of 2018-2022. In this study, it can be seen that the number of articles researching nano-sized agricultural waste brake pads has been increasing over the years. This shows that the phenomenon of the Coronavirus disease (Covid-19) pandemic has not prevented researchers from developing nano-sized agricultural waste brake pads. Research continues with a high number of publications in early 2022. Research that is being popularly studied by researchers today is about non-asbestos brake pads. To search using the keyword "Brake pads, Nano-sized, Agricultural waste" produces 6 clusters that have a different number of items in each cluster.

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