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Short Communication

Bibliometric analysis of research in *Moringa oleifera* Lam. and atherosclerosis

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ABSTRACT

Context: *Moringa oleifera* is a plant with many benefits, and its polyphenols have potential in the medication system due to their hypoglycemic activity. One of its functions is to prevent atherosclerosis by inhibiting the production of ROS.

Aims: To analyze the scope of the effect of *Moringa oleifera* on atherosclerosis research using a bibliometric review.

Methods: This investigation searched the Scopus electronic database for relevant articles on the effect of *M. oleifera* on atherosclerosis research. Basic bibliographic data were obtained through database analysis and citation reporting functions. This study exported the full bibliographic data to VOSviewer for further analysis. A visualization map was then created to reiterate the author's keywords and terms mentioned in the title and abstract of the publication.

Results: The data in this research included research trends and future research opportunities regarding *M. oleifera* on atherosclerosis. Around 1051 metadata articles on *M. oleifera* in relation to atherosclerosis were extracted from Scopus database. These articles were published between 2012 to 2022. The literature accepted contributions from all over the world, with the most productive countries being India, China, and Nigeria. Some of the most frequently cited themes, shown by keywords such as oxidative stress, *M. oleifera*, and diabetes, indicated that there had been numerous research progressing on these themes.

Conclusion: In relation to research on *M. oleifera* and atherosclerosis, there are still plenty of research topics that have not been widely covered, mainly those related to streptozotocin, dyslipidemia, and apoptosis, among others., which might be an opportunity for further research scope.

Keywords: atherosclerosis; bibliometrics; *Moringa oleifera*.

INTRODUCTION

Moringa oleifera Lam. (*Moringaceae*) is a plant that is widely grown around the world, but it is native to Middle Eastern countries such as India, Pakistan, and Bangladesh (Islam et al., 2021; Kong et al., 2019). *M. oleifera* is cultivated because it can exist in areas with long periods of drought. Therefore, it has economic value for use in tropical to sub-Saharan areas with low rainfall (Gedefaw, 2015; Oyeyinka and Oyeyinka, 2018). *M. oleifera* itself is widely used in community medicine for the treatment of various diseases. Globally, there has been a lot of validation of empirical research data regarding its phytochemical, pharmacological, and medicinal qualities, including research on efficacy against liver disease, diabetes (Muzumbukilwa et al., 2019; Oguntibeju et al., 2020), cancer, obesity, and kidney disease (Kitazawa et al., 2021). This plant has been used by the community in the past in the Indian ethnotherapy treatment system, in which it was reported that *M. oleifera* has hypoglycemic activity (Chen et al., 2017).

Meanwhile, atherosclerosis is an inflammatory process that contributes to the occurrence of acute myocardial infarction (AMI) and tends to be chronic. Atherosclerosis is a lipoprotein-driven disease leading to plaque formation at specific sites in the arteries due to intimal inflammation, necrosis, fibrosis, and calcification; the onset of thrombosis begins with plaque development until plaque rupture with exposure to necrotic core material rich in thrombogenic red blood cells (Sung et al., 2012). Increased production of reaction oxygen species or ROS has been proven in several studies caused by the TNF-a signaling cascade triggering endothelial cell dysfunction and apoptosis, resulting in atherosclerotic vascular disease (Jia et al., 2015; Madhur et al., 2011). The main source of ROS that occurs in the soft tissues of diabetic patients is nicotinamide adenine dinucleotide phosphate (NADPH) oxidase, which later develops and can cause atherosclerosis (Hansen et al., 2017; Schiffer et al., 2020). Furthermore, atherosclerosis is the leading cause of death and disability worldwide (Benjamin et al., 2017).

Although *M. oleifera* effects on atherosclerosis have been studied extensively, there are still numerous potential uses that may not have been described in detail. Therefore, the need for this comprehensive and

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systematic study from the past to the current trend would be in the hope of providing research opportunities and ideas in the future to fully utilize *M. oleifera* in the treatment of atherosclerosis. A thorough bibliometric study of *M. oleifera* on atherosclerosis was carried out specifically in the time span of 2012 to 2022. This study focused on participation and collaboration between authors, countries, and journals. Knowledge of *M. oleifera* against atherosclerosis in Scopus was examined over time with the defined search parameters. Therefore, this study provided a brief overview of the research reviews over several years, research trends in the future, and continuous novelty for interdisciplinary networks and collaboration between researchers.

METHODOLOGY

Data source and search methods

Publications from the Scopus database using the following keywords: "Moringa" AND "oleifera" AND "Moringa oleifera" AND "Atherosclerosis" were retrieved. Original articles and reviews in English were included along with being published during the period of 2012 to 2022. The total records of papers from the Scopus database obtained 1051 articles comprised of annual data, authors, and country of origin, among other details, in CSV format and opened in Excel 2010. The extracted data were then analyzed afterward using Microsoft Excel 2010 and VOSViewer's software.

Data analysis

From the downloaded data, Microsoft Excel 2010 successfully extracted the number of articles published by country, their percentage of the total number of publications, the citation frequency of publications in that region for each country, and the average citation frequency. The bar chart was drawn in Excel and VOSviewer software, and a bibliometric map was displayed. Each term (keyword, country, institution, and author) is represented by using a circle. A space between the circles indicates the strength of the relationship between the terms. Different clusters of terms were represented by different colors. Circle size correlated with word frequency and line width indicated the strength of the relationship between syllables (Guo et al., 2019; Rosado and De Souza, 2021; Zupic and Čater, 2015).

RESULTS AND DISCUSSION

Trends in the number and types of articles

From 2012 to 2022, the development of science on atherosclerosis and *M. oleifera* increased significantly. A total of 1051 publications were collected from 2012 to 2022. The growth and increase in scientific publications on *M. oleifera* and atherosclerosis were recorded in 2021, with the highest Scopus index reaching 237 publications (22.5%). The development of publications displayed a rising trend, followed by in 2020 and 2022 (159 publications or 15.3%) and in 2018 (90 publications or 8.28%) (Fig. 1A). From the type of document, 1051 publications were categorized into the top four categories of publications, namely: articles (712 publications), reviews (246 articles), chapter books (51 publications) and books (6 publications).

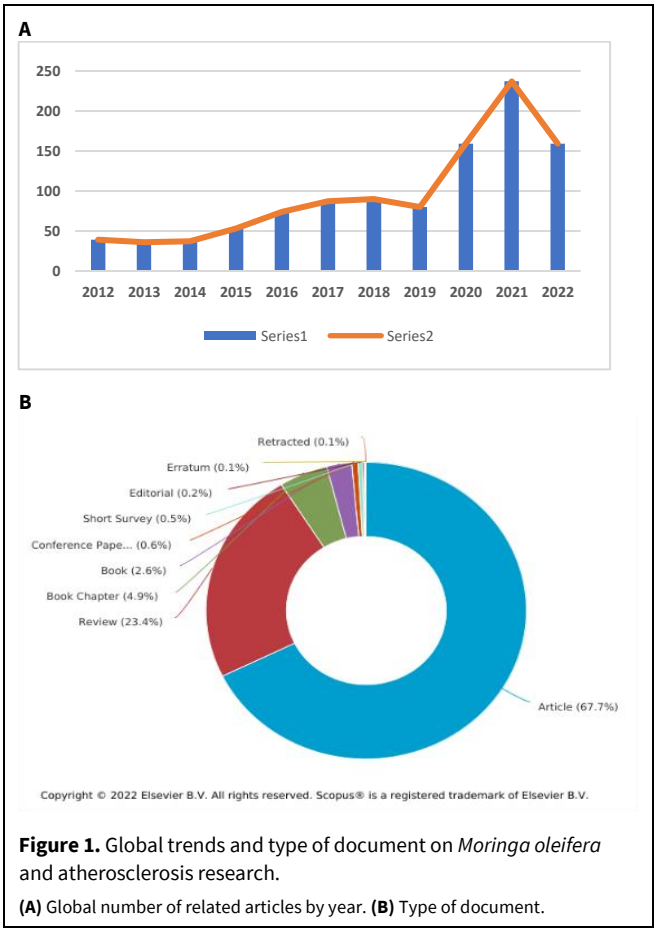

Figure 1. Global trends and type of document on *Moringa oleifera* and atherosclerosis research.
(A) Global number of related articles by year. **(B)** Type of document.

Distribution of publication documents by country

The most productive countries in conducting publications between 2012-2022 are shown in Fig. 2. India is the largest contributor to publications related to

M. oleifera and atherosclerosis. A similar finding was observed when the Medline (PubMed) database was analyzed, with India being the most productive country in research within this field (Dou and Kister, 2016). A collaborative network from various countries is shown in Fig. 2B. There were 73 countries divided into six different clusters. The individual components were arranged (circularly) to form clusters, and these clusters were connected by lines to show collaboration or network and its strengths (Chen et al., 2019; Kong et al., 2019). The strength of the network between countries in terms of referrals and citations would determine the thickness of the network line. Countries that ranked at the top of the publication chart were represented by a larger circle than others with low output. Overall, India (219), China (178), and Nigeria (84) had the highest total links.

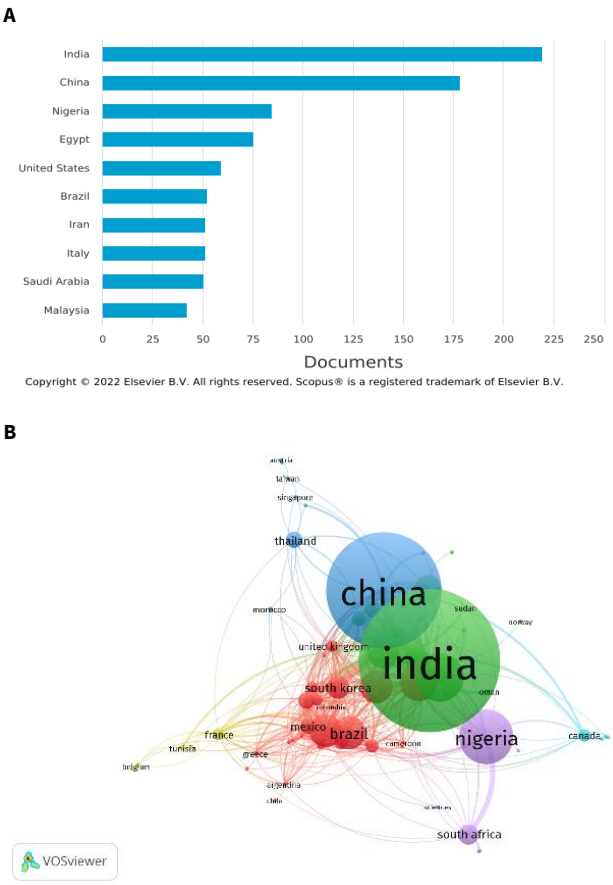

Figure 2. Global countries contributing to atherosclerosis.

(A) Top 10 countries with the most articles published. **(B)** Visual representation of international cooperation with other countries in 2012-2022.

Visualization of keywords by the author

Keyword search refers to publications containing the same keywords used together by the authors. The results of the keyword search reveal 3070 keywords related to *M. oleifera* and atherosclerosis; 94 keywords combined with the author's keywords met the specified search threshold shown in Fig. 3. Oxidative stress topped the search with 88 searches.

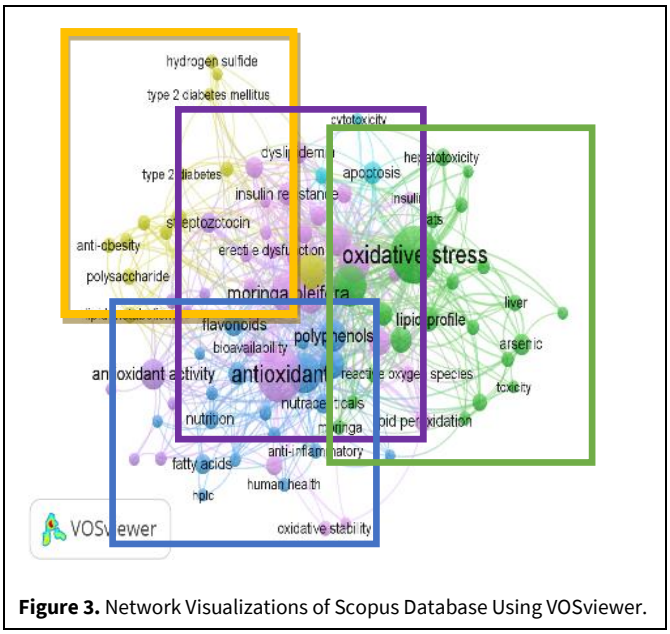

Figure 3. Network Visualizations of Scopus Database Using VOSviewer.

Table 1. Top 6 searching keywords.

Keywords	Frequency occurrence
Oxidative stress	88 searches
Antioxidant	81 searches
Moringa oleifera	48 searches
Inflammation	47 searches
Antioxidants	45 searches
Diabetes	41 searches

Other top keywords recorded were antioxidant (81 searches), *Moringa oleifera* (48 searches), inflammation (47 searches), antioxidants (45 searches), and diabetes (41 searches) (Table 1). These are the most common keywords included in the author's abstract, indicating that *Moringa oleifera* and atherosclerosis were being studied in fields such as pharmacology, biochemistry, and biomedical research. The publications related to atherosclerosis and *M. oleifera* were classified into four clusters [Fig. 3: Cluster 1 (Purple) includes keywords namely "antioxidant", "Moringa oleifera",

"antioxidants", "polyphenols", "antioxidant activity", "phytochemicals", "Flavonoids"; Cluster 2 (Yellow) includes keywords, namely "diabetes", "diabetes mellitus", "medical plants", "hyperlipidemia", "dyslipidemia", "Insulin resistance", "hypertension"; Cluster 3 (Green) with the keywords "Oxidative stress", "inflammation", "Obesity", "cholesterol", "lipid profile", "atherosclerosis"; and cluster 4 includes the keywords "erectile dysfunction", "lipid metabolism", "polysaccharide", "anti-obesity", "type 2 diabetes mellitus", and "hydrogen sulfide"].

Potential topics of *M. oleifera* and atherosclerosis in future publications

The development of research in the field of *M. oleifera* and its correlation with atherosclerosis is studied through the analysis of metadata imported into VOSviewer using blue, green, and yellow colors. The resulting density visualization, as shown in Fig. 4, shows the depth of research, displaying that the more concentrated the colors appear, the more increasing number of research. In addition, the level of saturation indicated by the many keywords that often appear can be taken from the yellow label around the label of oxidative stress, *M. oleifera*, antioxidants, flavonoids, polyphenols, metabolic syndrome, and atherosclerosis. This indicated that the area is a topic which has been extensively researched. In contrast to topics covered in green such as: type 2 diabetes, streptozotocin, dyslipidemia, apoptosis, lipid metabolism, etc. It exhibited that these topics were still not widely studied. In other words, this indication revealed the current gap in the existing research. Therefore, there would be numerous opportunities to conduct research on these topics.

CONCLUSION

The present study mapped the evolutionary and emerging trends of research on *Moringa oleifera* and atherosclerosis. Research on *Moringa oleifera* and atherosclerosis has been increasing in the last ten years. *Moringa oleifera* remains a versatile plant with multiple benefits to humans and has attracted researchers' interest in finding new frontiers and areas of exploration. It might be useful to conduct further research related to keywords, subjects, or other fields that match the results on visualization, for instance, streptozotocin, dyslipidemia, apoptosis, and lipid metabolism, among others. Researchers continue to exploit the *Moringa oleifera* pharmacological importance to maximize its utility for health, especially in preventing atherosclerosis.

CONFLICT OF INTEREST

The authors declare no conflicts of interest with the data contained in the document.

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