Moringa oleifera Research Trend: A Bibliometric Analysis

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Abstract: Moringa (Moringa oleifera) has long been recognized as a plant that has many health benefits from the mythical side compared to the scientific side. Scientific studies that reveal Moringa oleifera are considered urgent to do from a theoretical, empirical, and methodological perspective. The purpose of the study was to analyze research trends on Moringa oleifera in various studies in the field of science. The research method uses a literature review of articles with the keyword Moringa oleifera published from 2000 to 2023. Theoretical, empirical, and methodological reviews are carried out through bibliometric map analysis using the VOSviewer application. The research findings show: 1) 963 articles were published in reputable journals indexed by Scopus using the keyword Moringa oleifera; 2) theoretically, Moringa oleifera is proven to have many health benefits, including nutritional content, anti-inflammatory effects, antioxidant activity, anti-diabetic effects, and anti-cancer effects; 3) empirically, research trends on the topic of Moringa oleifera revolve around anti-inflammatory activity, effects, anatomical structure, experimental subjects, content, active substances, and preparations; 4) methodologically, Moringa oleifera research trends use experiments with studies in the fields of medical science, nutrition, and pharmacology; and 5) potential topics of study on Moringa oleifera include anti-inflammatory effects, antioxidant properties, anti-fatigue, and nutritional value, as well as muscle recovery. Comparative causal research on the effects of Moringa oleifera on inflammatory processes and mitochondrial biogenesis of the lungs is very potential and recommended for further research.

Keywords: Anti-inflammation, Bibliometric, Literature Review, Mitochondrial Biogenesis, Moringa oleifera.

INTRODUCTION

Moringa oleifera (hereinafter Moringa) is known as a good source of energy that can be used in traditional medicine to treat certain diseases (such as: skin infections, scurvy, tumors, bronchitis, anemia, etc.) (Haldar & Kosanka, 2017) and cosmetics as the oil from the seeds can be used for hair and skin care. The seeds are rich in vitamins and minerals, and the seed extract can be used as an antibacterial, can produce high-quality cooking oil rich in antioxidants, and a water purifier as it has a natural coagulation effect that can help remove impurities from water (Islam, et al., 2021). The plant is also known for its diverse properties, for example, it has 10 times more vitamins than carrots, 7 times more vitamin C than oranges, 17 times more calcium than milk, and 15 times more potassium than bananas (Rockwood, Anderson, & Casamatta, 2013).

The various benefits and uses of this Moringa plant, over time, eventually made Moringa known as a "miracle plant" (Daba, 2016; Haldar & Kosankar, 2017; Rajbhar, Rajbhar, PL, Shukla, & Kumar, 2018; Islam, et al., 2021) and gave rise to myths about Moringa. One of the common myths about Moringa is that it is believed to cure a wide range of diseases as it has many potential health benefits. However, it is important to understand that Moringa is not a cure-all and should not be relied upon as the sole treatment for any medical condition.

Various studies regarding Moringa are mostly researched by health, nutrition, and pharmacology variables with the research method often used is the experimental method. Meanwhile, research on Moringa with bibliometric methods is still rarely found. On the basis of this explanation, scientific studies that reveal Moringa using the bibliometric method are considered urgent to do from a theoretical, empirical, and methodological perspective. Therefore, this study aims to analyze how the development of trend research on Moringa in various studies in the field of science.

METHOD

The method used is a quantitative with bibliometric analysis to collect, summarize, and analyze various articles that describe past and current information (Creswell, 2012). The sample of articles used in the study was 963 articles with the keyword Moringa oleifera with the following criteria: 1) articles published from 2000 to 2023; 2) articles published journals indexed by Scopus; and 3) have been reviewed by researchers. Data analysis used in theoretical, empirical, and methodological reviews through bibliometric map analysis using the *VOSviewer* application. This bibliometric analysis is used to summarize and visualize large amounts of bibliometric data to present the state of intellectual structures and trends (Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021) of Moringa. The stages of this bibliometric analysis consist of six main stages: determining search terms or keywords, selecting databases and determining selection criteria for searches, collecting data, bibliometric analysis by *VOSviewer*, summarizing bibliometric analysis, presenting results and making conclusions.

RESULTS

Based on the results of the literature review that has been carried out, 963 articles were obtained published in journals indexed by Scopus using the keyword Moringa oleifera. After going through

the literature screening and selection process, 20 articles were selected because they met the predetermined criteria. The results of the final study are described as follows.

Table 1. Results obtained

No	Title	Author & Year	Research Sample	Results
		Theoretical Sides		
1.	Moringa: A food plant with multiple medicinal uses	(Anwar, Latif, Ashraf, & Gilani, 2007)	-	Many parts of Moringa can be used as stimulants, anti-tumor, anti-pyretic, anti-epileptic, anti-inflammatory, anti-ulcer, anti-spasmodic, diuretic, anti-hypertensive, cholesterol-lowering, antioxidant, anti-diabetic, hepatoprotective, anti-bacterial and anti-fungal properties.
2.	Health benefits of Moringa	(Razis, Ibrahim, & Kntayya, 2014)	-	Moringa can be used as human food, and provides nutritional benefits, antioxidants, antibiotics, contains vitamins and minerals.
3.	Review of the safety and efficacy of Moringa	(Stohs & Hartman, 2015)	-	Many parts of Moringa widely used in traditional medicine, food products in human nutrition, and shows high antioxidant activity.
4.	Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of Moringa leaves: An overview	(Leone, et al., 2015)	-	Moringa is used as food, medicine, water purification, biopesticide, and biodiesel production.
5.	Moringa: A review on nutritive importance and its medical application	(Gopalakrishnan, Doriya, & Kumar, 2016)	Moringa	Moringa can be used as an anti-cancer, anti-diabetic, and anti-oxidant, a strong neuroprotector, water purifier, cosmetics, seasoning, and as a snack food.
6.	Bioactive components in Moringa leaves protect against chronic disease	(Vergara-Jimenez, Almatraf, & Fernandez, 2017)	-	Moringa is a good strategy for various conditions related to heart disease, diabetes, cancer and fatty liver.
7.	Nutritional and medicinal applications of Moringa lam: Review of current status and future possibilities	(Gupta, Jain, Kachhwaha, & Kothari, 2018)	Moringa research as of March 2017	Moringa is highly contained minerals and has multidimensional utility that serves as an excellent reservoir for pharmaceuticals and nutraceuticals.
8.	Biological, nutritional, and therapeutic significance of Moringa lam	(Dhakad, et al., 2019)	Database on Moringa Lam and its chemical uses	The phytochemicals in Moringa are beneficial for food fortification and can be used in traditional medicine practices.
		Empirical Side		
1.	Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (Moringa Lam.) leaves	(Siddhuraju & Becker, 2003)	Moringa leaves extract	Moringa is a potential source of natural antioxidants.

2.	Moringa oil: A possible source of biodiesel	(Rashid, Anwar, Moser, & Knothe, 2008)	Moringa oil	Moringa oil is a potential or acceptable feedstock for biodiesel.
3.	Antioxidant activity and total phenolic content of Moringa leaves in two stages of maturity	(Sreelatha & Padma, 2009)	Moringa leaves	Extract of Moringa leaves has strong antioxidant activity against free radicals and provides significant protection against oxidative damage.
4.	Evaluation of the polyphenol content and antioxidant properties of methanol extracts of the leaves, stem, and root barks of Moringa lam.	(Atawodi, et al., 2010)	Moringa leaves, bark, and roots	The methanol extract of Moringa leaves contains chlorogenic acid, quercetin glucoside, and kaempferol rhamnoglucoside.
5.	Nutritional characterization of Moringa leaves	(Moyo, Masika, Hugo, & Muchenje, 2011)	Dried Moringa leaves	Moringa leaves are nutrient-rich and have the potential to be used as a feed additive for various purposes, being a source of protein, fatty acids, minerals, and vitamins for animal and human feed formulations.
6.	Maximizing total phenolics, total flavonoids contents and antioxidant activity of Moringa leaf extract by the appropriate extraction method	(Vongsak, et al., 2013)	Moringa mature leaves	Maceration with 70% ethanol is the most suitable extraction method for Moringa dried leaves and the most potent antioxidant activity.
7.	Soluble extract from Moringa leaves with a new anticancer activity	(Jung, 2014)	Moringa extracts	Moringa extract showed greater cytotoxicity for tumor cells compared to normal cells.
8.	Antioxidant and anti-inflammatory activities of the crude extracts of Moringa from Kenya and their correlations with flavonoids	(Xu, Chen, & Guo, 2019)	Young leaves, seeds, and roots of Moringa	Many parts of Moringa are rich in flavonoids and phenolic acids, with different contents. Moringa leaves have more flavonoids and phenolic acids compared to other parts.
		Methodological Side		
1.	Moringa mitigates memory impairment and neurodegeneration in animal model of age-related dementia	(Sutalangka, Wattanathorn, Muchimapura, & Thukham-mee, 2013)	Moringa leaf extract and Male Wistar Rats	Moringa leaf extract has neuroprotective and memory-enhancing effects, making it a potential cognitive enhancer and neuroprotector.
2.	Moringa aqueous leaf extract down-regulates nuclear factor-kappaB and increases cytotoxic effect of chemotherapy in pancreatic cancer cells	(Berkovich, et al., 2013)	Moringa leaves extract	Moringa leaf extract can inhibit pancreatic cancer cell growth, NFκB signaling pathways, and improve the effectiveness of chemotherapy on human pancreatic cancer cells.
3.	Nutritional characterization and phenolic profiling of Moringa leaves grown in Chad, Sahrawi Refugee Camps, and Haiti	(Leone, et al., 2015)	Moringa leaves native to Haiti, Chad, and Southwestern Algeria	Moringa leaves are a good and economical source of nutrients, and promising food supplement to overcome malnutrition in tropical and sub-tropical areas.
4.	Biogenic synthesis of iron oxide nanorods using Moringa leaf	(Aisida, et al., 2019)	Moringa extract	Nanoparticles formed from $FeCl_3$ and Moringa extract as reducing agents, proved to be a good, efficient, and

extract for antibacterial applications	supplemented with $FeCl_3$	promising antibacterial agent because it is cost-effective, non-toxic, and has an easy synthesis procedure in the therapeutic biomedical field.

Furthermore, the trend of Moringa research focus is depicted in the following table.

Table 2. Research Trend of Moringa

No.	Year	Focus
		Theoretical Side
1.	2007	Treatment of several diseases
2.	2014	Multipurpose herbal plant
3.	2015	Food product, medicine, water purifier, biopesticide, biodiesel production, safety of use, and the effectiveness of its use
4.	2016	Effects of Moringa as an anti-cancer, anti-diabetic, anti-oxidant, and strong neuroprotector
5.	2017	Heart disease, diabetes, cancer and fatty liver
6.	2018	Multidimensional utility plant that serves as an excellent reservoir for drugs and nutraceuticals
7.	2019	Therapeutic or healing activities and prevention of several disorders
		Empirical Side
1.	2003	Potential source of antioxidants
2.	2008	Raw material for biodiesel
3.	2009	Against free radicals and prevention of oxidative damage
4.	2010	Content in each part (anatomical structure)
5.	2011	As feed, medicinal properties, diet, health and nutrition improvement
6.	2013	Extraction methods
7.	2014	Potential or benefits of Moringa extract
8	2019	Content of each part of the Moringa plant and potential products in the future.
		Methodological Side
1.	2013	On health, field of medicine, and pharmacological field
2.	2015	Field of nutrition
3.	2019	Pharmacological and biomedical fields.

DISCUSSION

Moringa research findings theoretically when associated with health benefits, have such diverse benefits and can be useful for certain diseases. The research findings are in accordance with several literature sources such as Moringa provides good nutritional benefits (Razis, Ibrahim, & Kntayya, 2014), can be used as a food product in nourishing humans, has a high level of safety, and its leaves do not have side effects on humans (Stohs & Hartman, 2015), is rich in vitamins, carotenoids, polyphenols, phenolic acids, flavonoids, alkaloids, glucosinolates, isothiocyanates, tannins, and saponins (Leone, et al., 2015), 2015), can be used as an anti-cancer, anti-diabetic, antioxidant, strong neuroprotector, and can be used as a snack food to eradicate malnutrition (Gopalakrishnan, Doriya, & Kumar, 2016), be a good strategy for heart disease, diabetes, cancer,

and fatty liver (Vergara-Jimenez, Almatraf, & Fernandez, 2017), a plant with multidimensional utility that serves as an excellent reservoir for drugs and nutraceuticals (Gupta, Jain, Kachhwaha, & Kothari, 2018), can be used as a heart and circulatory stimulant (Anwar, Latif, Ashraf, & Gilani, 2007), and can be used as antibiotic, antitumor, anti-inflammatory, cardio-protective, hepato-protective, neuro-protective, tissue protective, and other biological activities with a high level of safety (Dhakad, et al. , 2019).

Empirically, Moringa research findings, especially with regard to its research trends are also very diverse. *First*, in terms of anti-inflammatory activity and the effects it produces, such as research conducted by Xu, Chen, & Guo (2019) which aims to compare how the antioxidant and anti-inflammatory activities of crude ethanol extracts of Moringa leaves, seeds, and roots, as well as how the correlation between differential activity and the chemical content of these three parts of the Moringa plant; as well as research conducted by Jung (2014) which shows that Moringa soluble extracts have the potential to provide therapeutic implications for the treatment of various types of cancer. *Second*, anatomical structure, such as the research of Atawodi, et al., (2010) which uses Moringa plant parts (leaves, stems, and roots) as its research sample to analyze polyphenol content and antioxidant potential in vitro. *Third*, experimental subjects, such as the research of Vongsak, et al., (2013) which made dried leaves of Moringa as experimental subjects in their research with maceration extraction method with 70% ethanol content. *Fourth*, content and active substances, such as research by Siddhuraju & Becker (2003) which states that Moringa is a potential source of natural antioxidants; and research by Sreelatha & Padma (2009) states that Moringa has strong antioxidant activity against free radicals, preventing oxidative damage to major biomolecules. *Fifth*, research by Rashid, Anwar, Moser, & Knothe (2008) which states that Moringa can be used as oil and its oil can be a potential or acceptable raw material for biodiesel and research conducted by Moyo, Masika, Hugo, & Muchenje (2011) which states that Moringa has the potential to be used as a feed additive for various purposes, because it is a source of protein, fatty acids, minerals, and vitamins for animal feed formulations and can be used as food for humans.

In addition, the findings of Moringa research methodologically also show that the trend of Moringa research using experiments covers a variety of scientific studies, ranging from medicine (Sutalangka, Wattanathorn, Muchimapura, & Thukham-mee, 2013), nutrition (Leone, et al., 2015), and pharmacology (Berkovich, et al., 2013; Aisida, et al., 2019).

CONCLUSION

Moringa is proven to have many health benefits, including nutritional content, anti-inflammatory effects, antioxidant activity, anti-diabetic effects, and anti-cancer effects. Empirically, research trends on the topic of Moringa range in terms of anti-inflammatory activity, effects produced, anatomical structure, experimental subjects, content, active substances, and preparations. Methodologically, Moringa research trends use experiments with studies in the fields of medicine, nutrition, and pharmacology. For this reason, potential topics of study on Moringa include anti-inflammatory effects, antioxidant properties, anti-fatigue, and nutritional value, as well as muscle recovery, such as comparative causal research on the effects of Moringa on inflammatory processes and mitochondrial lung biogenesis.

Acknowledgment

The authors are very grateful to Universitas Pendidikan Indonesia for supporting and facilitating the research.

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