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Phytochemical Composition, Elemental Profile, Proximate Analysis, Antioxidant Potential, and Antimicrobial Activity of *Morinda citrifolia* (Noni) Seed Extract

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Abstract: This study investigates the phytochemical composition, elemental profile, proximate analysis, antioxidant potential, and antimicrobial activity of *Morinda citrifolia* (Noni) seed extract. Methanol extraction was used, and qualitative screening revealed the presence of glycosides, phenolics, eugenols, terpenoids, alkaloids, and flavonoids, while saponins, steroids, and tannins were absent. Quantitative analysis showed significant levels of flavonoids (59.63 mg/ml), phenolics (24.44 mg/ml), alkaloids (1.46%), and tannins (8.75 mg/ml). Elemental profiling indicated high concentrations of magnesium (21.33 mg/ml) and potassium (20.46 mg/ml), with moderate calcium, sodium, iron, zinc, and copper. Proximate analysis revealed 49.94% crude fiber, 13.78% crude fat, 13.40% ash, 5.69% protein, and 17.19% carbohydrates, highlighting its nutritional potential. Antioxidant activity showed a maximum DPPH scavenging capacity of 67.30% at 500 µg/ml with an IC_{50} of 129.30 mg/ml. Antimicrobial assays revealed selective activity against *Staphylococcus aureus* (14 mm inhibition zone at 500 mg/ml), with no activity against other tested organisms. These findings demonstrate that *M. citrifolia* seeds are a rich source of bioactive compounds, essential nutrients, and natural antioxidants with promising applications in nutraceuticals and antimicrobial formulations.

1. Introduction

Medicinal plants have long been recognized for their potential in treating various ailments due to their rich reservoir of bioactive compounds such as alkaloids, terpenoids, and polyphenols… (Gallego *et al.*,2019; Diass *et al.*,2021; Kadda *et al.*, 2022; Ouahabi *et al.*,2023; Ahmad *et al.*,2025). One such plant, Morinda citrifolia, commonly known as noni, has gained considerable attention for its diverse pharmacological properties. *M. citrifolia* belongs to the Rubiaceae family and is widely distributed across tropical and subtropical regions, including Southeast Asia, Polynesia, and Africa. Various parts of the plant, including its fruits, leaves, bark, roots, and seeds, have been extensively used in traditional medicine to treat ailments such as infections, inflammation, diabetes, and cancer (Jahurul *et al.*,2021). Recent studies have focused on the phytochemical composition and biological activities of noni seed

extract, highlighting its potential as a natural source of antioxidants and antimicrobial agents. The bioactivity of M. citrifolia is primarily attributed to its rich phytochemical composition. Phytochemicals such as flavonoids, alkaloids, tannins, saponins, and steroids have been identified in various extracts of noni seeds (Haruna *et al.*,2020). These compounds are known for their significant antioxidant, antimicrobial, and anti-inflammatory properties, which contribute to the plant's medicinal efficacy (Piaru *et al.*,2011; Merzouki *et al.*,2023; Merimi *et al.*,2025).

Flavonoids, for instance, exhibit strong free radical scavenging activity, thereby preventing oxidative damage to cells and reducing the risk of chronic diseases such as cancer and cardiovascular disorders (Piaru *et al.*,2011; Mehiou *et al.*, 2025; Mukherjee *et al.*, 2025). Similarly, alkaloids and tannins have demonstrated antibacterial and antifungal effects, making noni seed extract a promising candidate for developing natural antimicrobial agents (Usha *et al.*, 2010; Fitriana and Fajril Islami, 2025). Beyond its phytochemical constituents, the nutritional and elemental composition of noni seeds further underscores their health benefits. Studies have shown that noni seeds are rich in essential minerals such as calcium, magnesium, iron, and manganese, which play crucial roles in physiological functions, including enzyme activation and metabolic regulation (Jahurul *et al.*,2021). Proximate analysis has also revealed that noni seeds contain significant amounts of dietary fiber, protein, and healthy fats, supporting their potential use in functional foods and nutraceuticals (Desai & Gaikwad, 2010). The presence of polyunsaturated fatty acids and bioactive lipids in noni seed oil further enhances its nutritional value, particularly for individuals seeking natural alternatives to synthetic supplements (Jahurul *et al.*,2021). Oxidative stress, caused by an imbalance between reactive oxygen species (ROS) and antioxidants, is a major contributor to chronic diseases such as cancer, neurodegenerative disorders, and cardiovascular diseases. Natural antioxidants, particularly those derived from plant-based sources, play a vital role in neutralizing free

radicals and mitigating oxidative damage (Piaru *et al.*,2011). The antioxidant potential of *M. citrifolia* seed extract has been well documented, with studies demonstrating its ability to scavenge free radicals through mechanisms such as hydrogen donation and metal ion chelation (Thani *et al.*,2010). The high polyphenolic content of noni seed extract contributes significantly to its antioxidant activity, making it a valuable resource for preventing oxidative stress-related disorders (Piaru *et al.*,2011). The increasing prevalence of antibiotic-resistant pathogens has necessitated the search for alternative antimicrobial agents. Natural plant extracts, including those derived from *M. citrifolia*, offer a promising solution due to their broad-spectrum antimicrobial properties. Studies have shown that noni seed extract exhibits potent antibacterial activity against both Gram-positive and Gram-negative bacteria, including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa (De La Cruz-Sánchez *et al.*,2019). This antibacterial effect is largely attributed to the presence of flavonoids, alkaloids, and coumarins, which disrupt bacterial cell membranes and inhibit microbial enzyme activity (Usha *et al.*,2010). Additionally, noni seed extract has demonstrated antifungal activity against *Candida albicans* and Aspergillus niger, further highlighting its potential as a natural antimicrobial agent (Usha *et al.*,2010). Given the promising pharmacological properties of M. citrifolia seed extract, this study aims to comprehensively evaluate its phytochemical profile, elemental and proximate composition, antioxidant potential, antimicrobial activity and to consolidate the findings through a bibliometric analysis using Scopus and VOSviewer. By elucidating these properties, the study seeks to provide a scientific basis for the potential application of noni seed extract in the development of natural therapeutics and functional food products.

2. Methodology

2.1 Sourcing and preparation of Noni seed

Noni fruit were locally sourced from Ekiadolor Community in Ovia North East Local Government Area of Edo State, Nigeria. It was identified by Dr. Akinnibosun from the Department of Plant Biology and Biotechnology University of Benin, with voucher number UBH-N427. The seed was removed from the fruit. The fresh seed of the plant was air dried at room temperature till complete dryness. The dried seed were pulverized into powder using the British milling machine. The weight of the powdered seed was taken and stored in a dried container for further studies.

2.2 Experiments

2.2.1 Extraction of Morinda citrifolia

Extraction of the seed and stem bark of Noni was carried out using maceration method as reported by Aghedo and Ogbeide (2022**)** using methanol as the solvent of extraction. Five hundred of the each sample was soaked differently in methanol (1:2 of sample and methanol) and allowed to stay for 3 days (72 hours) with constituent stirring. Using filter paper Whatman no. 1, the sample was filtered to separate the extract from the residue and gets a residue-free extract. The extract was then concentrated using rotary evaporator, dried and stored in a refrigerator for further use with percentage yield calculated.

2.3 Phytochemical Screening

The Phytochemical examination of the plant extract were carried out using standard methods as employed by Tiwari et al.,2001, Trease and Evans (2002**)** with little modification**.**

2.3.1 Total Phenolic Contents Determination

Using tannic acid as a reference, the Folin–Ciocalteu reagent was used to measure the amount of total phenolic in the extract, slightly altering Singleton and Rossi's **(**1965**)** method. In summary, 1.0 ml of extract solution (250 ug/ml) was put into a test tube. The contents of the flask were well mixed after 1.0 ml of the Folin-Ciocalteu reagent was added. Five minutes later, 15.0 ml of 20% Na_2CO_3 were added, and the mixture was left to stand for two hours. A UV-Vis spectrophotometer (Janay 6100, Dunmow, Essex, U.K.) was used to measure the absorbance at 760 nm. An algorithm based on the standard calibration graph of tannic acid was used to calculate the total phenolic content, which is expressed as Ug of tannic acid equivalent (TAE).

2.3.2 Determination of Total Alkaloids Content

The Harborne **(**1973**)** method was used to measure the total alkaloid content. After weighing 5g of the extract into a 250 mL beaker, 100 mL of 20% acetic acid in ethanol was added, and the mixture was let to stand for two hours. After filtering, a water bath was used to concentrate the extract to a quarter of its initial volume. Once the precipitation was complete, concentrated ammonium hydroxide was added drop by drop to the extract. The precipitate was then filtered out, washed with 1% ammonia solution, dried, and weighed after the entire solution had been given time to settle. Every sample was analyzed three times:

$$\text{Alkaloid (\%)} \frac{\text{Weight of residue}}{\text{Weight of sample}} x100 \qquad \textbf{Eqn. 1}$$

2.3.3 Flavonoid Content Determination

Three separate aliquots of the homogeneous plant extract (1.5 g) were used to measure the flavonoid concentration (Ilahy *et al.*,2011). For the purpose of determining the flavonoids, thirty microliter aliquots of the methanolic extract were utilized. 90 µL of methanol was used to dilute the samples, followed by the addition of 6 µL of 10% aluminum chloride ($AlCl_3$), 6 µL of 1mol/l sodium acetate (CH_3CO_2Na), and 170 µL of methanol. After 30 minutes, the absorbance was measured at 415 nm.
Quercetin was used as a standard for calculating the flavonoid content (Ug Qe/g).

2.3.4 Estimation of Tannins Content

After adding precisely 0.20 mL of the sample to 20 mL of 50% methanol, the mixture was agitated and kept in a water bath between 77°C and 80°C for an hour. After quantitatively filtering the extract using a double-layered Whatman No. 1 filter paper, 10 mL of 17% Na_2CO_3, 2.5 mL of Folin-Denis reagent, and 20 mL of distilled water were added and combined. For twenty minutes, the mixture was left to stand. After color development, the absorbance of the samples and a series of standard tannic acid solutions made in methanol were measured using a UV/visible spectrophotometer set to 760 nm. The calibration curve was used to determine the total tannin concentration.

2.4 Elemental Analysis

An atomic absorption spectrophotometer was used to ascertain the amount of calcium, magnesium, iron, copper, and zinc, while a flame photometer was used to measure sodium and potassium (Osarumwense *et al.*, 2022). 1 gram of the sample was placed in a beaker, 10 milliliters of each of the nitric and perchloric acids were added to a beaker, and the sample was then placed inside. After the solution had been digested, 10 milliliters of distilled water were added, filtered into a volumetric flask after being shaken. Distilled water was used to dilute the filtrate to 100 mL. Following preparation, the

sample was examined for minerals using an atomic absorption spectrophotometer and a flame photometer.

2.5 Proximate Analysis

Moisture content, total Ash content (Aghedo and Ogbeide, 2022), crude fibre determination (AOAC 1980), crude fat determination (Pearson 1976), crude protein determination (micro-Kjeldahl method as described by AOAC (1990), estimation of total carbohydrate (Adamu, *et al.*,2017) were carried out respectively using the ascribed standard methods.

2.6 Estimation of Antioxidant activity

The scavenging action of M. citrifolia seed and stem bark crude methanol extracts, respectively Unuigbe et al. (2021), described a method for determining the DPPH radical. Three milliliters (3ml) of each extract were combined with one milliliter (1 ml) of a 0.2 mM DPPH in methanol solution that contained 0.001-0.200 mg/ml of the extracts. After giving it a thorough vortex, It was left in the dark for 30 minutes at room temperature. A spectrophotometer was used to measure the absorbance at 518 nm. The standard was ascorbic acid. The ability to scavenge DPPH was calculated using the following equation: DPPH radical Scavenging Activity:

$$\% = Ao - A1 \qquad \textbf{Eqn. 2}$$

Where, Ao=absorbance of DPPH radical plus methanol; A1=absorbance of DPPH radical plus sample

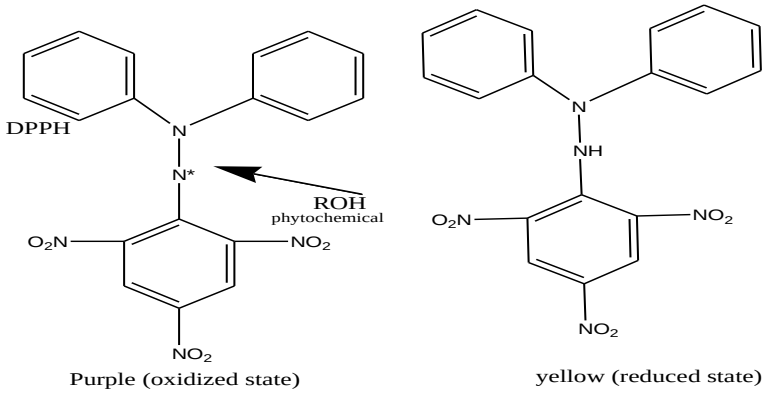

Figure 1. Antioxidant activity

2.7 Antimicrobial activity

2.7.1 Bacteria Isolates

Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Streptococcus, Candida albicans, and Aspergillus flavus were among the bacterium isolates employed in this investigation. These organisms were obtained from the University of Benin Teaching Hospital's microbiology lab in Benin City, Nigeria. Their identities were verified through morphological, biochemical, and cultural tests. The bacteria cultures were cultivated in nutrient agar at 4°C and kept on nutrient agar slopes.

2.7.2 Determination of antibacterial activity: The antibacterial activity was assayed by the agar-well diffusion method as reported by Aghedo and ogbeide (2022), where the minimum inhibition concentration (MIC) and minimum bactericidal concentration (MBC) was investigated.

2.7.3 Statistical Analysis

Some of the experiments were carried out in triplicate, some in duplicate and some once. Average values of triplicate and duplicate determinations were used and Standard deviation was calculated for the results.

3. Results and Discussion

Emergence of new active drugs used in combating drug-resistance ailment is mostly traceable to plant source. In this study, methanol extract of Noni seed were subjected to phytochemical screening, Elemental analysis, proximate analysis, antioxidant study and antimicrobial analysis.

3.1 Bibliometric analysis

It is worthwhile to conduct a bibliometric analysis of studies on *Morinda citrifolia* using Scopus and VOSviewer. This analysis provides greater visibility into the most prolific countries and authors, along with their collaborations (N'diaye *et al.*, 2022; Laita *et al.*, 2024; You *et al.*, 2024; Isman *et al.*, 2025). More than 1860 articles were collected during the period 1878 to 2025. Our study describes the evolution of production (1793 articles) on *M. citrifolia* from 2000 to 2025. In 2024 and 2025, around 126 articles were published showing the importance of this natural plant (**Figure 2**). The most cited paper (551 citations) titled "Green synthesis of metallic nanoparticles as effective alternatives to treat antibiotics resistant bacterial infections" was published by Sing *et al.*, (2020). This paper describes the role of metal nanoparticles coupled to plant extract in biological activities. For example, gold NPs from root extract of *M. citrifolia* were also found to be antimicrobial in nature (Suman *et al.*, 2014). India stands out scientifically in several areas. This study shows that India is the most prolific producer of this natural plant (362 articles), followed by the USA (240 articles), Indonesia (215 articles), Malaysia (200 articles), and China (171 articles), as shown in **Figure 3**. This finding can be presented in the map VOSviewer where 106 countries contributed. Only 106 countries published at least 5 articles. India is shown by the largest mustard circle called "node", the US is indicated by a purple node, a green node for Indonesia, a blue one for Malaysia, and the red node for Brazil (**Figure 4**).

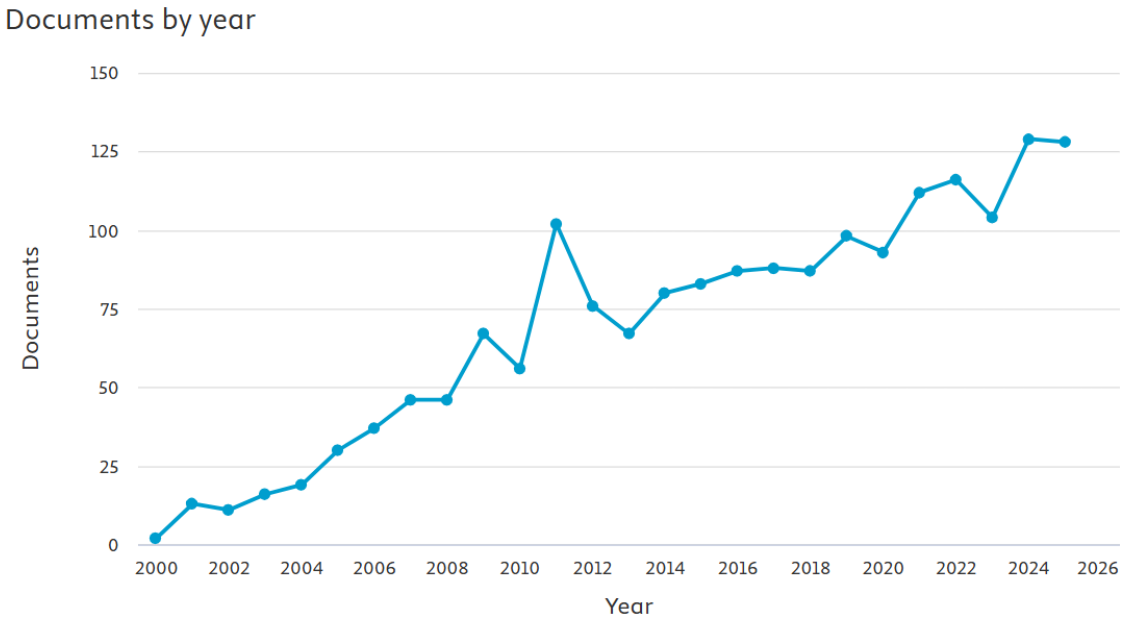

Figure 2. Evolution of production on *M. citrifolia* from 2000 to 2025.

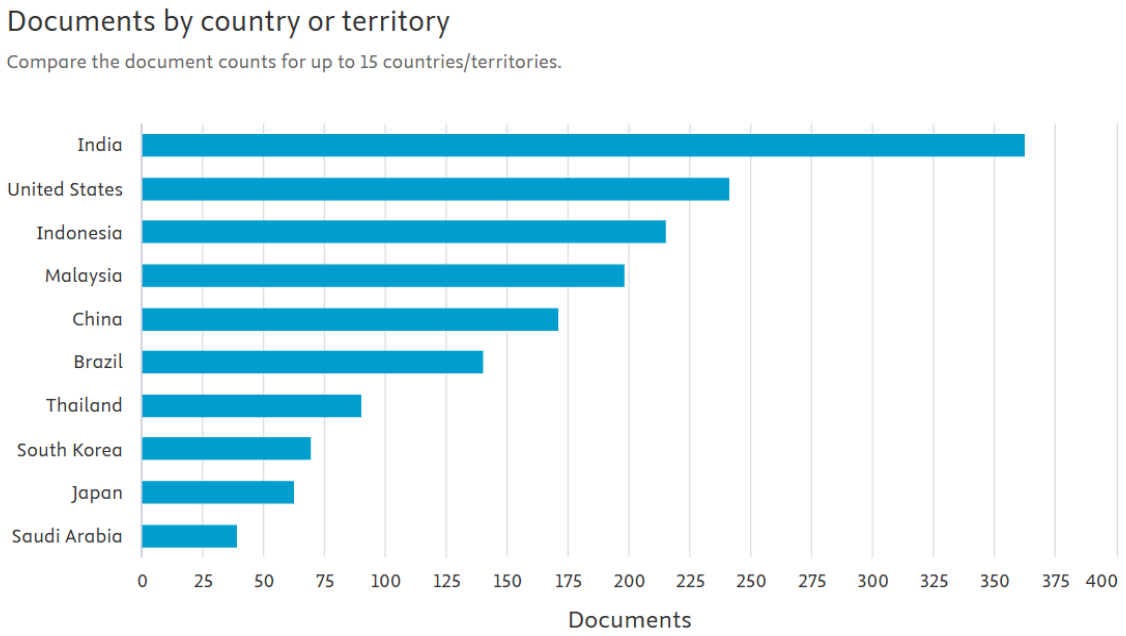

Figure 3. Top ten Countries publishing on *M. citrifolia* from 2000 to 2025.

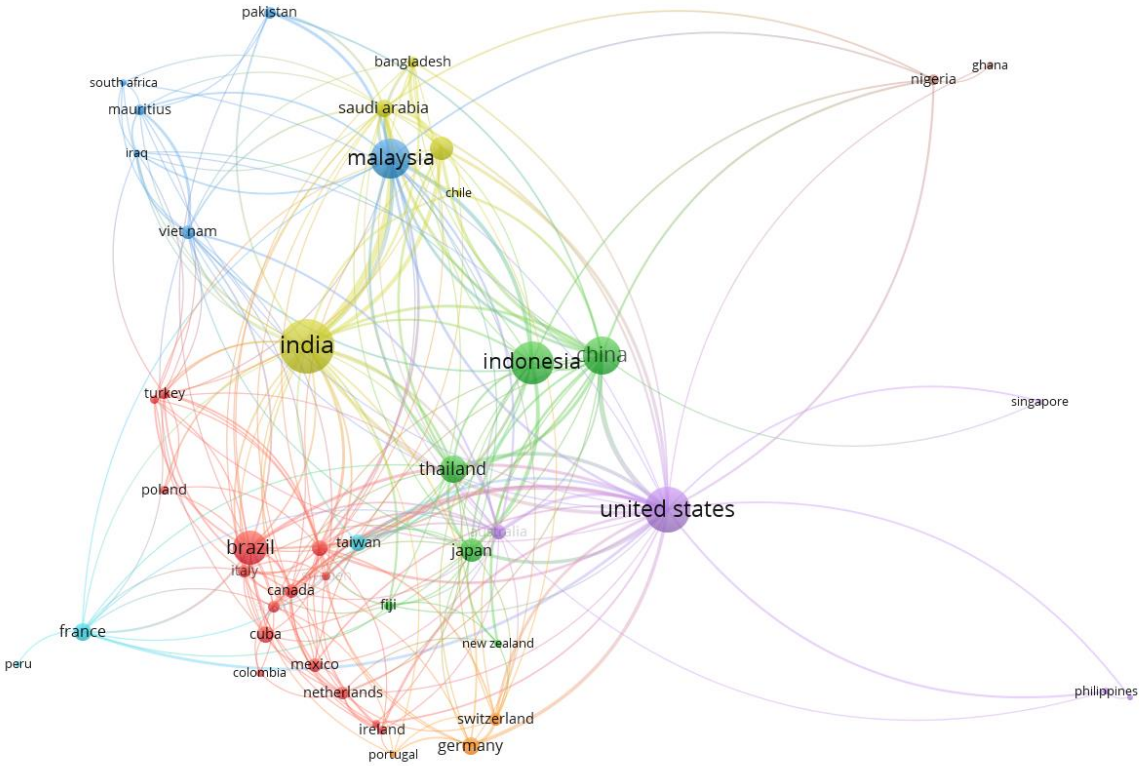

Figure 4. Network visualization of Countries publishing on *M. citrifolia* from 2000 to 2025.

Scopus analysis ranked the top ten authors by number of papers (**Figure 5**). 141 authors published at least 5 articles among a total of 6619 authors gathered by Scopus/VOSviewer. The American West B.J. is the most published author (38 articles), his compatriot Deng S. (24 articles), and Jensen C.J. (18 articles), all from American Fork, United States. The VOSviewer map visualizes 18 authors at different colored nodes (**Figure 6**). The largest blue node is attributed to West, Deng, Jenson, and Westendorf. The interconnected blue nodes indicate that they belong to the same institution (American Fork).

This research uses mapped bibliometric analysis, such as data density visualization, in which color density corresponds to the frequency of author occurrence, providing insight into the intensity of research focus (Gandasari *et al.*, 2024; Hammouti *et al.*, 2025). The density of the colors indicates the high level of research. **Figure 7** showed West B.J. with high-density yellow. The other authors have less dense colors. 1793 articles have been distributed on Agriculture, Medicine, Pharmacology, Biochemistry,… **Figure 4**(right). Furtheremore, the repartition of documents by type indicates that authors prefer articles, reviews, conference papers (>93%) to ensure their promotion or PhD defense, **Figure 4** (left).

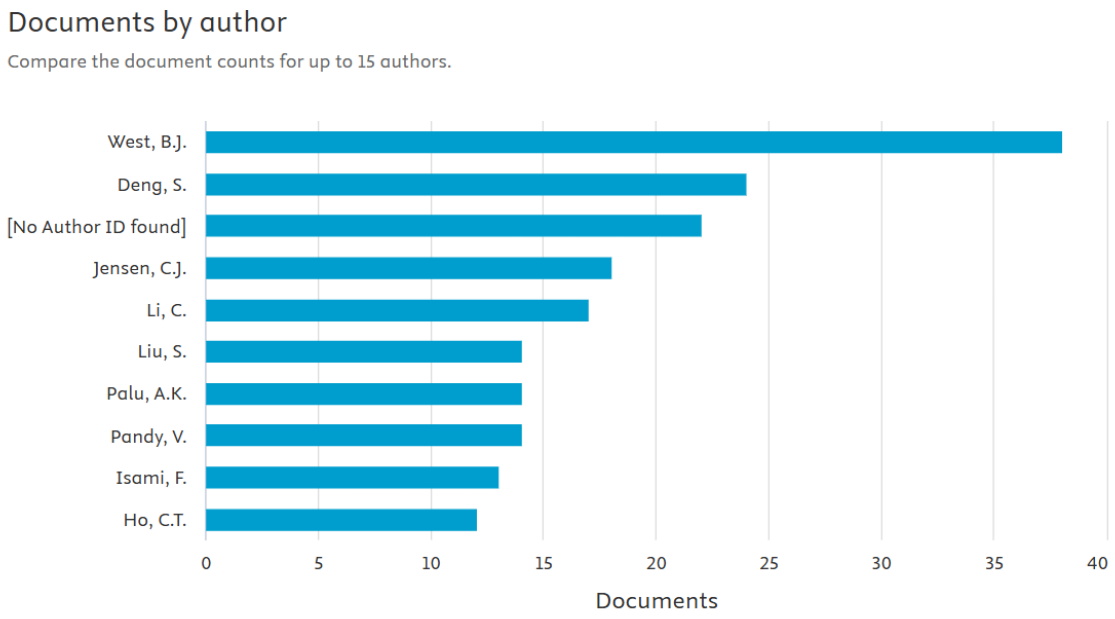

Figure 5. Top ten authors publishing on *M. citrifolia* from 2000 to 2025.

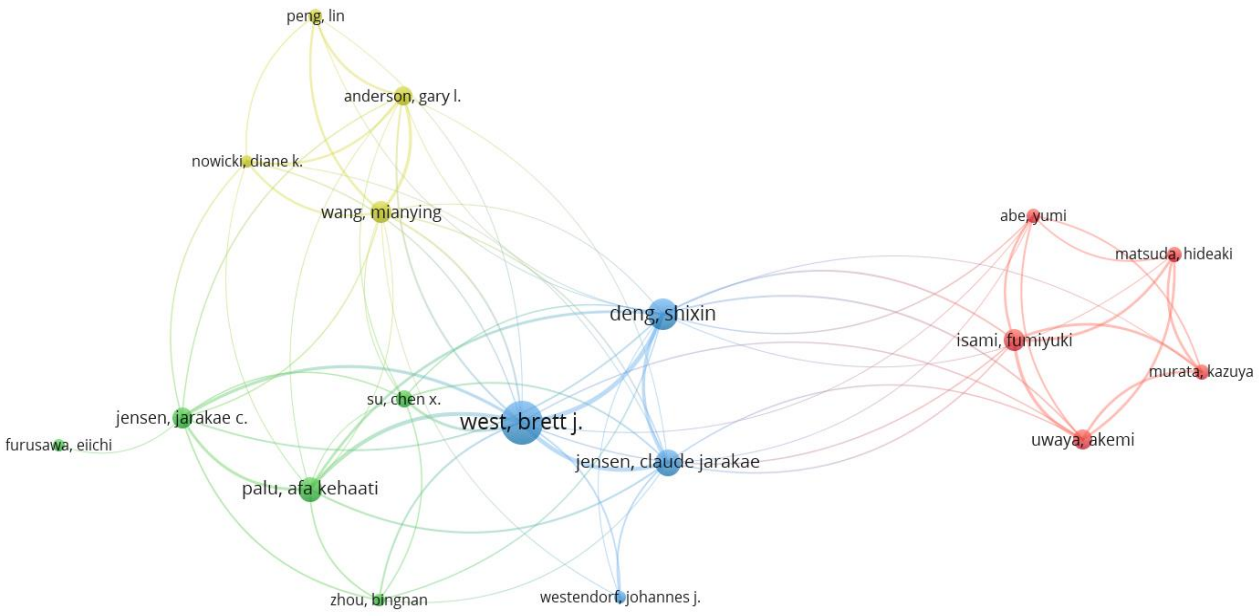

Figure 6. Network visualization of Countries publishing on *M. citrifolia* from 2000 to 2025.

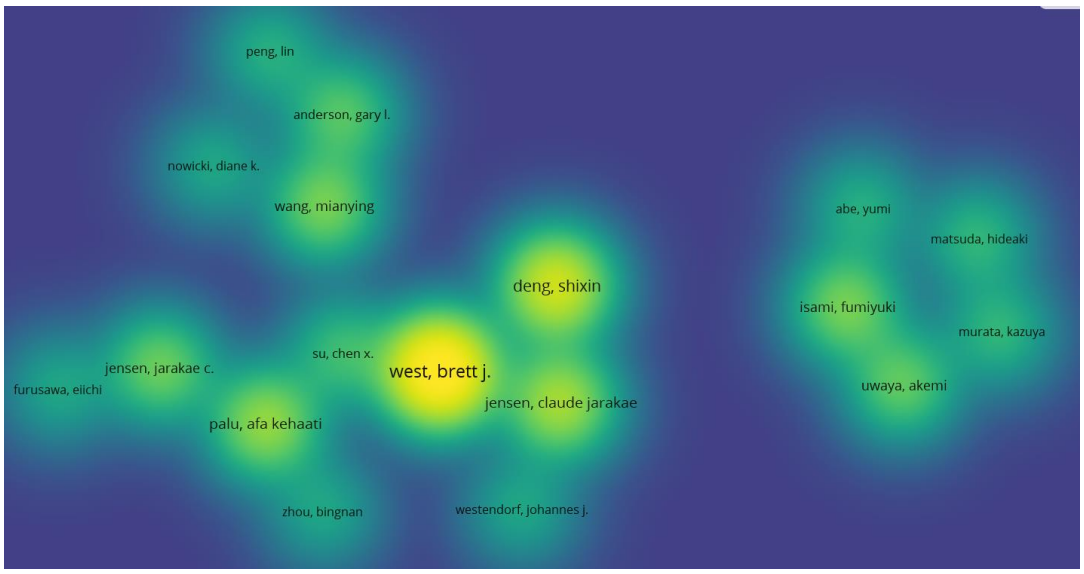

Figure 7. Density visualization of Countries publishing on *M. citrifolia* from 2000 to 2025.

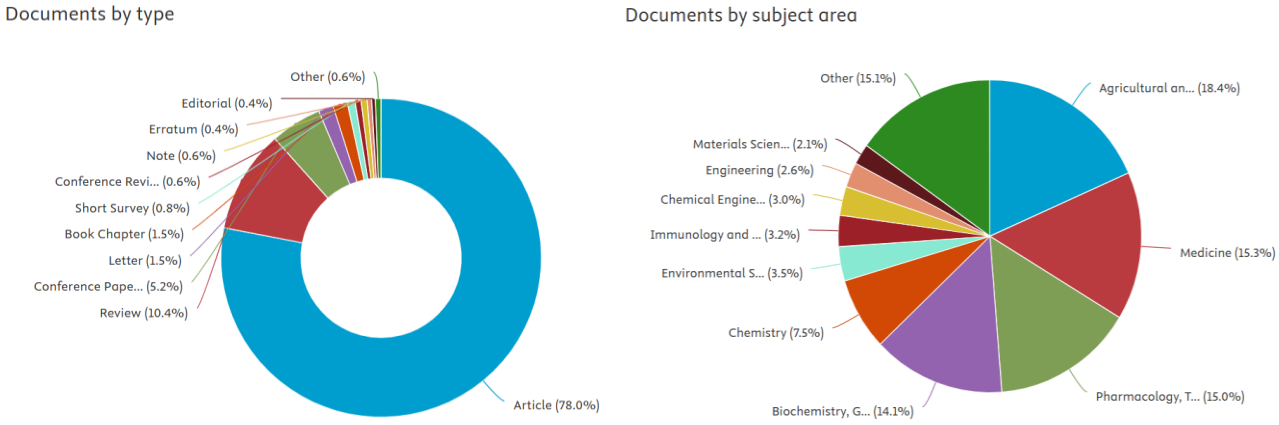

Figure 8. Documents published by Type (right) and subject area (left)

3.1 Phytochemical Composition of Noni Seed Extract

Phytochemicals are secondary metabolites produced by plants that play a significant role in their defense mechanisms and have been widely studied for their therapeutic potential in human health. *Morinda citrifolia*, commonly known as Noni, is a tropical plant traditionally used in folk medicine for its wide range of health benefits. This study focuses on the phytochemical screening of the methanol extract of Noni seeds, revealing the presence and absence of various bioactive compounds, which provide insights into its potential pharmacological applications (Table1).

The methanol extract of *Morinda citrifolia* seeds was screened for various phytochemicals, and the results are summarized in **Table 1**. The analysis revealed the presence of glycosides, phenolics, eugenols, terpenoids, alkaloids, and flavonoids, while saponins, steroids, and tannins were absent. The methanol extract of *Morinda citrifolia* (Noni) seeds reveals a rich phytochemical profile with significant therapeutic potential. Glycosides, known for their cardiotonic and anti-inflammatory properties, suggest cardiovascular benefits, including improved heart function and circulation (Kumar *et al.*,2013).

Table 1. Result of phytochemical screening of Morinda citrifolia (Noni) seed

	Morinda citrifolia (Noni) seed
Glycoside	+
Saponin	-
Phenolic	+
Eugenols	+
Terpenoid	+
Steroids	-
Alkaloids	+
`Flavonoids	+
Tannins	-

+ means present - means absent

Phenolic compounds, potent antioxidants, indicate strong free radical scavenging activity, which may help prevent chronic diseases such as cancer, diabetes, and neurodegenerative disorders (Pandey & Rizvi, 2009). Eugenols, with their analgesic, anti-inflammatory, and antimicrobial properties, highlight potential applications in pain management and infection control (Daniel *et al.*,2009). Terpenoids, exhibiting anti-inflammatory, antiviral, and anticancer effects, further underscore the therapeutic potential of Noni seeds (Thoppil & Bishayee, 2011). Alkaloids, known for their diverse pharmacological effects, including analgesic and anticancer properties, add to the medicinal value of the extract (Zhang *et al.*,2022). Flavonoids, recognized for their antioxidant, anti-inflammatory, and anticancer activities, further support the health benefits of Noni seeds, particularly in combating oxidative stress and inflammation (Panche *et al.*,2016). However, the absence of saponins, steroids, and tannins suggests limited contributions to immune modulation, certain anti-inflammatory effects, or wound healing (Sasidharan *et al.*,2011). Overall, the presence of these bioactive compounds highlights the potential of Noni seeds in developing therapeutic agents for various health conditions, warranting further research to isolate and characterize their specific pharmacological effects. These findings align with previous studies that have highlighted the medicinal value of Noni in traditional and modern medicine (Wang *et al.*,2002; Potterat & Hamburger, 2007).

3.1.1 Quantitative Phytochemical Analysis of Morinda citrifolia (Noni) Seed Methanol Extract.

The methanol extract of *Morinda citrifolia* (Noni) seeds demonstrates a notable concentration of key bioactive compounds, as shown in **Table 2**. The quantitative phytochemical profile reveals alkaloids (1.460%), phenolic compounds (24.436 mg/ml), tannins (8.750 mg/ml), and flavonoids (59.630 mg/ml). These values provide critical insights into the extract's pharmacological potential and align with its traditional medicinal uses. The quantitative data refine our understanding of Noni seed photochemistry. While qualitative screening previously indicated the absence of tannins, the quantitative detection suggests methodological differences in sensitivity (e.g., colorimetric assays vs. HPLC). In contrast, Emieje *et al*. (2024) discovered the presence of tannin using qualitative method, although, water was used as a solvent of extraction. However, the difference could be in the solvent of extraction, Qualitative Cutoffs: a "+" or "−" result depends on arbitrary visual thresholds.

Table 2. Result of total Alkaloids, phenolic, tannins, and flavonoids of Morinda citrifolia (Noni) seed and stem bark

	Alkaloids (%)	Phenolic (mg/ml)	Tannins (mg/ml)	Flavonoids (mg/ml)
Morinda citrifolia (Noni) seed	*1.460*	*24.436*	*8.750*	*59.630*

If the tannin concentration was near the detection limit (e.g., 5–10 mg/ml), slight variations in protocol could lead to inconsistent results, this is why quantitative is also essential. The high flavonoid and phenolic concentrations align with Noni's traditional use in treating oxidative stress-related conditions (Samarasinghe *et al.,* 2023). Notably, the alkaloid content supports its role in pain relief, while tannins, though present in lower amounts, may synergize with other compounds to enhance antimicrobial activity.

3.2 Elemental Composition of *Morinda citrifolia* (Noni) Seed Extract

The methanol extract of *Morinda citrifolia* (Noni) seeds contains essential macro- and micro-elements, as quantified in Table 3. The predominant minerals include magnesium (21.33 ±6.600 mg/ml) and potassium (20.46 ±4.910 mg/ml), which play critical roles in enzymatic functions, nerve transmission, and cellular homeostasis (Soetan *et al.*,2010). Calcium (2.35 ±0.131 mg/ml) and sodium (4.04 ±2.305 mg/ml) are present at moderate levels, contributing to bone health and electrolyte balance, respectively (Weaver, 2013). Trace elements such as iron (1.30 ±0.497 mg/ml), zinc (0.19 ±0.056 mg/ml), and copper (0.01 ±0.005 mg/ml) are also detected, albeit in lower concentrations. Iron supports oxygen transport and redox reactions, while zinc and copper are vital cofactors for antioxidant enzymes like superoxide dismutase (Bhattacharya *et al.*,2024)

Table 3. Result of elemental analysis of methanol extract of *Morinda citrifolia* seed and stem

ELEMENTS	*MORINDA CITRIFOLIA (NONI)* SEED (mg/ml) (Mean ±SD)
Sodium (Na)	4.04 ±2.305
Potassium (K)	20.46 ±4.910
Calcium (Ca)	2.35 ±0.131
Magnesium (Mg)	21.33 ±6.600
Iron (Fe)	1.30 ±0.497
Copper (Cu)	0.01 ±0.005
Zinc (Zn)	0.19 ±0.056

The high magnesium and potassium content aligns with Noni's traditional use in managing hypertension and metabolic disorders, as these minerals regulate blood pressure and glucose metabolism (Silva *et al.*,2018). Notably, the low copper levels minimize risks of toxicity, which is critical for safe therapeutic applications (Kabata-Pendias, 2011).

3.3 Proximate Analysis

Using a methanol extract of Noni seed and stem bark, the proximate analysis's findings shows the percentage of the moisture content, crude fiber, ash content, crude fat, crude protein and total carbohydrates of the samples as shown in the table below. Morinda citrifolia (Noni) seeds represent an underutilized by-product of the noni juice industry with significant nutritional potential. The proximate analysis revealing 18.33% moisture, 49.94% crude fiber, 13.40% ash, 13.78% crude fat, 5.69% crude protein, and 17.19% total carbohydrates, as presented in **Table 4**, provides a foundation for understanding how each component contributes to human health (Oly-Alawuba and Iwunze, 2019). This analysis examines the health implications of each nutritional component and evaluates whether this composition profile supports noni's reputation as a beneficial plant for human health. Noni seeds are exceptionally rich in crude fiber, with levels reported as high as 49.94%, far surpassing many conventional seeds. Studies have also recorded 28.7% crude fiber in the seeds, significantly higher than the pulp (0.03%) and concentrate (1.95%). This remarkable fiber content offers multiple health benefits, including improved digestive function, better blood sugar regulation (Samarasinghe *et al.*,2024), reduced cholesterol levels for cardiovascular health (Jahurul *et al.*,2021), and enhanced satiety to support weight management. Combined with their phenolic compounds, noni seeds hold strong potential as a functional food with both nutritional and therapeutic value (Oly-Alawuba and Iwunze, 2019).

Table 4. Result of proximate analysis of methanol extract of M. citrifolia seed and stem bark

PARAMETERS	*MORINDA CITRIFOLIA (NONI)* SEED (%)
Moisture content	18.330 ±0.057
Crude fiber	49.940 ±0.055
Ash content	13.400 ±0.050
Crude fat	13.780 ±0.055
Crude Protein	5.690 ±0.005
Total carbohydrates	17.190 ±0.020

Noni seeds contain 13.78% crude fat, rich in polyunsaturated fatty acids—primarily linoleic acid (71.74%)—along with phytosterols and tocopherols (Jahurul *et al.*, 2021). These components provide essential fatty acids, support cardiovascular health, and offer antioxidant benefits. The oil's high iodine value (125.90 g I_2/100 g) and low free fatty acid content (1.07%) indicate good quality and stability (Jahurul and Shahidul, 2022). Noni seeds exhibit notable nutritional density, with an ash content of 13.40%—substantially higher than the pulp (1.06%) and concentrate (0.79%)—indicating a rich mineral profile (Oly-Alawuba and Iwunze, 2019). They provide essential minerals such as sodium, potassium, magnesium, calcium, phosphorus, iron, and zinc, which contribute to bone health, enzymatic function, electrolyte balance, and oxygen transport (Etsuyankpa *et al.*,2017). The seeds also contain 5.69% protein, modest in quantity yet rich in essential amino acids including glutamic acid, leucine, and aspartic acid. This quality protein, supported by functional properties and good digestibility, makes noni seeds a valuable source of biologically important proteins, especially compared to other parts of the fruit (Ulloa, 2023). Carbohydrates make up 17.19% of the seed composition, offering both structural (fiber) and non-

structural energy components. This combination supports sustained energy release, brain and muscle metabolism, and potential prebiotic effects. Collectively, the high mineral, quality protein, and balanced carbohydrate content position noni seeds as a functional food ingredient with significant nutritional and health benefits.

3.4 Anti-oxidant

The table below (**Table 5**) shows the % inhibition (scavenging capacity) of the sample, showed variation at different concentration as shown in the table below. **IC_{50}** is a measure of the concentration of a substance that is required to inhibit 50% of a biological process. It is commonly used to measure the potency of drugs and other bioactive compounds. In the context of antioxidant activity, IC_{50} is the concentration of an antioxidant that is required to inhibit 50% of the oxidation of a free radical. The lower the IC_{50}, the more potent the antioxidant **(**Ekhator *et al.*,2022; Unuigbe *et al.*,2021).

%inhibition (scavenging capacity)

Table 5. Result of antioxidant analysis of Morinda citrifolia (Noni) seed

Concentration (µg/ml)	Seed (%)	Ascorbic acid (%)
500	67.299	87.777
400	34.034	83.547
300	15.992	43.977
200	19.510	14.370
100	18.760	16.430

Table 6. IC_{50} result for the methanol extract of Morinda citrifolia (Noni) seed

	IC_{50} (mg/mL)
Morinda citrifolia seed	129.300
Ascorbic acid	46.548

3.5 Anti-microbial

3.5.1 Zone of inhibition at concentration of (500mg/ml) of Morinda citrifolia (Noni) seed

The antimicrobial test of methanol extract showed antimicrobial activity only with Staphylococcus aureus as shown in the table below.

3.5.2 MIC and MBC (mg/ml) of Noni seed at different concentration (Staphylococcus Aureus).

Furthermore, MIC and MBC tests were also carried out at different concentration, the table below displays the findings. The result of the MIC of methanol extract of Noni seed showed no growth at concentration of 200mg/ml, but showed growth at 100mg/ml and 50mg/ml for the seed extract. The result of the MBC of methanol extract of Noni seed showed growth at concentration of 200mg/ml, 100mg/ml and 50mg/ml. Noviana *et al*. **(**2021**)** reported active antibacterial activities against *E. coli and Staphylococcus aureus* of the Noni seed using diffusion method. This effect was traceable to the secondary metabolites of flavonoid and phenol present in the seed.

Table 7. **Result of antimicrobial activity of *Morinda citrifolia* (Noni) seed**

Organism	***Morinda citrifolia (Noni)* seed (500 mg/ml)**
Staphylococcus Aureus	14mm
Escherichia Coli	Nz
Pseudomonas Aeruginosa	Nz
Streptococcus	Nz
Candida Albicans	Nz
Aspergillus Flavus	Nz

Table 8. **Result of MIC methanol extract of Morinda citrifolia (Noni) seed and stem bark *Morinda citrifolia (Noni) seed***

Organism	**200mg/ml**	**100mg/ml**	**50mg/ml**
Staphylococcus Aureus	NG	G	G

Table 9. ***Result of MBC and Morinda citrifolia (Noni) seed***

Organism	**200mg/ml**	**100mg/ml**	**50mg/ml**
Staphylococcus Aureus	G	G	G

Conclusion

This study reveals the therapeutic potential of *Morinda citrifolia* (Noni) stem bark and seed extracts, rich in phytochemicals with antioxidant and antimicrobial properties. The stem bark demonstrated superior antioxidant and antimicrobial activity, particularly against *Staphylococcus aureus*, despite the seed's higher phenolic content. These findings highlight the stem bark's potential for health supplements and natural antimicrobials. Further research on active compounds, broader microbial testing, and dose optimization is needed to fully harness its medicinal benefits

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References

Aghedo, O. N., & Ogbeide, O. K. (2022). Proximate composition, acute toxicity and antimicrobial activity of methanol extract of Picralima nitida stem bark. *ChemSearch Journal*, *13*(2), 92-98.

Ahmad M, Tahir M, Hong Z, Zia MA, Rafeeq H, Ahmad MS, Rehman Su and Sun J (2025) Plant and marine-derived natural products: sustainable pathways for future drug discovery and therapeutic development. *Front. Pharmacol.* 15, 1497668. doi: 10.3389/fphar.2024.1497668

Bhattacharya M. (2024). Antioxidants activity of micronutrients and macronutrients. In *Micronutrients and Macronutrients as Nutraceuticals* (pp. 47-88). Apple Academic Press.

Daniel, A. N., Sartoretto, S. M., Schmidt, G., Caparroz-Assef, S. M., Bersani-Amado, C. A., & Cuman, R. K. N. (2009). Anti-inflammatory and antinociceptive activities of eugenol essential oil in experimental animal models. *Revista Brasileira de Farmacognosia*, 19(1B), 212-217.

De La Cruz-Sánchez, N. G., Gómez-Rivera, A., Alvarez-Fitz, P., Ventura-Zapata, E., Pérez-García, M. D., Avilés-Flores, M., ... & González-Cortazar, M. (2019). Antibacterial activity of Morinda citrifolia Linneo seeds against Methicillin-Resistant Staphylococcus spp. *Microbial pathogenesis*, *128*, 347-353.

Desai, N., Gaikwad, D. K., & Chavan, P. D. (2010). Proximate composition and some physicochemical properties of morinda pulp. *Int. J. Applied Bio. Pharma. Tech*, *1*(2). 672 -682

Diass K., Brahmi F., Mokhtari O., *et al*. (2021). Biological and pharmaceutical properties of essential oils of Rosmarinus officinalis L. and Lavandula officinalis L., *Materials Today: Proceedings*, 45(8), 7768-7773. https://doi.org/10.1016/j.matpr.2021.03.495

Ekhator, O. C., Osarumwense, E. P., Akowe, A. B., Egbe, U. J., Aghedo, N. O., Omozuwa, O. P., & Ekhator, C. M. (2022). Antioxidant and chelating effects of Citrus sinensis peel extract on wistar rats administered with lead and cadmium. *Bio-Research*, *20*(3), 1638-1648.

Etsuyankpa, M. B., Ndamitso, M. M., Oluwatoyin, I. V., Ibrahim, H., & Ogah, S. P. I. (2017). Chemical analysis of noni (Morinda citrofolia) seeds and the characterization of the seeds oil. *American Journal of Applied Chemistry*, 5(4), 11.

Fitriana W.D., Fajril Islami M. (2025). Antioxidant and antibacterial activities of Noni fruit (Morinda citrifolia) extract. *Jurnal Kimia Riset*, 10(1), 92–101. https://doi.org/10.20473/jkr.v10i1.64966

Gallego, R., Bueno, M., and Herrero, M. (2019). Sub-and supercritical fluid extraction of bioactive compounds from plants, food-by-products, seaweeds and microalgae–An update. *Trac. Trends Anal. Chem.* 116, 198–213. doi:10.1016/j.trac.2019.04.030

Hammouti B., Aichouch I., Kachbou Y., Azzaoui K., Touzani R. (2025) Bibliometric analysis of global research trends on UMI using Scopus database and VOS viewer from 1987–2024, *J. Mater. Environ. Sci.*, 16(4), 548-561

Haruna, A., Ismail, S. I., Omar, D., & Mohamed, M. T. M. (2020). Qualitative analysis of some bioactive components of methanolic leaf extract of *M. citrifolia* (Noni). *Journal of Medicinal Herbs and Ethnomedicine*, *6*(1), 38-41.

Jahurul, M. H. A., & Shahidul, I. (2022). Physicochemical and antioxidant properties, total phenolic and nutritional contents of noni (Morinda citrifolia) seed and its oil cultivated in Sabah, Malaysia. Food Chemistry Advances, 1, 100673.

Jahurul, M. H. A., Patricia, M., Shihabul, A., Norazlina, M. R., George, M. R. R., Noorakmar, A. W., Lee, J. S., Jumardi, R., Jinap, S., & Zaidul, I. S. M. (2021). A review on functional and nutritional properties of noni fruit seed (*Morinda citrifolia* L.) and its oil. *Food Bioscience*, 41, 101000.

Jahurul, M. H. A., Patricia, M., Shihabul, A., Norazlina, M. R., George, M. R. R., Noorakmar, A. W., Lee, J. S., Jumardi, R., Jinap, S., & Zaidul, I. S. M. (2021). A review on functional and nutritional properties of noni fruit seed (Morinda citrifolia L.) and its oil. Food Bioscience, 41, 101000.

Kabata-Pendias, A. (2011). Trace elements in soils and plants/fourth editions. *CRC Taylor and Francis Group, Boca Raton, 505*.

Kadda, S., Belabed, A., Loukili, E.H., B. Hammouti, S. Fadlaoui (2022), Temperature and extraction methods effects on yields, fatty acids, and tocopherols of prickly pear (Opuntia ficus-indica L.) seed oil of eastern region of Morocco. *Environ Sci Pollut Res* 29, 158-166. https://doi.org/10.1007/s11356-021-16752-8

Kumar, S., Pandey, A. K., & Singh, S. (2013). Glycosides as potential medicinal components in plants. *Journal of Medicinal Plants Research*, 7(42), 3093-3100.

Laita M., Sabbahi R., Elbouzidi A., *et al*. (2024) Effects of Sustained Deficit Irrigation on Vegetative Growth and Yield of Plum Trees Under the Semi-Arid Conditions: Experiments and Review with Bibliometric Analysis, *ASEAN Journal of Science and Engineering*, 4(2), 167-190

Mehiou A., Alla C., Akissi Z.L.E., Dib I., Abid S., Berraaouan A., Mekhfi H., *et al*. (2025). Cardiovascular Effects, Antioxidant Activity, and Phytochemical Analysis of Rubus ulmifolius Schott Leaves. *Plants.* 14(16), 2513. https://doi.org/10.3390/plants14162513

Merimi C., Benabbou A., Bourassi L., *et al*. (2025) In silico evaluation of bioactive compounds (flavonoids, rosmarinic acid) from five plants (Rosemary, Oregano, Pink Savory, Lemon Balm, and Saffron) and their role in cardiovascular health and hypertension, *OBM Integrative and Complementary Medicine*, 10(2), 27; https://doi.org/10.21926/obm.icm.2502027

Merzouki, M., Bekkouch, A., Alkowni, R., Bourassi, L., Abidi, R., Bouammali, B., Hammouti, B., Azzaoui, K., Jodeh, S., & Challioui, A. (2023). Flavone Derivatives as Potential Inhibitors of SARS-Cov-2rdrp through Computational Studies. *Journal of Biochemical Technology*, 14(4), 74-82. https://doi.org/10.51847/Bo9tanDZ4G

Mukherjee, B. et al. (2025). Antioxidants and Their Physiological Role in Free Radical Scavenging. In: Mukherjee, B. (eds) Dietary Supplements and Nutraceuticals. Springer, Singapore. https://doi.org/10.1007/978-981-96-8622-3_12

N'diaye A.D., Kankou M.S.A., Hammouti B., Nandiyanto A.B.D., Al Husaeni D.F. (2022). A review of biomaterial as an adsorbent: From the bibliometric literature review, the definition of dyes and adsorbent, the adsorption phenomena and isotherm models, factors affecting the adsorption process, to the use of typha species waste as adsorbent. *Communications in Science and Technology*, 7(2), 140-153. https://doi.org/10.21924/cst.7.2.2022.977

Oly-Alawuba and Iwunze (2019). Evaluation of Nutrient, Antinutrient and Phytochemical Properties of Noni Fruit (*Morinda citrifolia*); (Concentrate, Pulp, And Seed). *Current Development in Nutrition***,** P10-047-19.

Oly-Alawuba, N., & Iwunze, A. A. (2019). Evaluation of nutrient, antinutrient and phytochemical properties of noni fruit (Morinda citrifolia) concentrate, pulp, and seed. *Journal of Food Science and Engineering*, 9(9), 003.

Osman M.A., Sheikh Farah A.A., Abdi A.I. (2025). A bibliometric analysis of sustainable development research in higher education institutions (HEIs): key trends, global collaborations and influential contributions (2015–2023). *Cogent Education*, 12(1). https://doi.org/10.1080/2331186X.2025.2490436

Ouahabi S., Loukili E.H., Daoudi N.E., Chebaibi M., Ramdani M., Rahhou I., Bnouham M., Fauconnier M-L., Hammouti B., Rhazi L., Gotor A.A., Dépeint F., Ramdani M. (2023) Study of the Phytochemical Composition, Antioxidant Properties, and In vitro Anti-diabetic Efficacy of Gracilaria bursa-pastoris Extracts, *Marine Drugs*, 21(7), 372; doi.org/10.3390/md21070372

Panche, A. N., Diwan, A. D., & Chandra, S. R. (2016). Flavonoids: An overview. *Journal of Nutritional Science*, 5, e47.

Pandey, K. B., & Rizvi, S. I. (2009). Plant polyphenols as dietary antioxidants in human health and disease. *Oxidative Medicine and Cellular Longevity*, 2(5), 270-278.

Pearson, D. (1976). The chemical analysis of foods.

Piaru, S. P., Mahmud, R., Abdul Majid, A. M. S., Ismail, S., & Nin Man, C. (2011). Chemical composition, antioxidant, and cytotoxic activities of the essential oils of *Myristica fragrans* and *Morinda citrifolia*. *Journal of the Science of Food and Agriculture*, *92*(5), 593-597.

Potterat, O., & Hamburger, M. (2007). *Morinda citrifolia* (Noni) fruit—phytochemistry, pharmacology, safety. *Planta Medica*, 73(03), 191-199.

Samarasinghe, H. G. A. S., Illeperuma, D. C. K., & Gunathilake, K. D. P. P. (2023). Evaluation of antioxidant, anti-inflammatory and anti-diabetic properties of noni fruit (Morinda citrifolia L.) and its simulated gastrointestinal digesta fractions. *Journal of Food and Bioprocess Engineering*, *6*(1), 59-68.

Samarasinghe, H. G. D. S., Gunathilake, K., & Illeperuma, D. C. K. (2024). Proximate composition, bioactive constituents, and therapeutic potentials of pasteurized Noni juice derived from Morinda citrifolia (L.) growing in Sri Lanka. *Ceylon Journal of Science*, 53(1), 8141.

Sasidharan, S., Chen, Y., Saravanan, D., Sundram, K. M., & Yoga Latha, L. (2011). Extraction, isolation and characterization of bioactive compounds from plants' extracts. *African Journal of Traditional, Complementary and Alternative Medicines*, 8(1), 1-10.

Silva Figueiredo, P., Inada, A. C., Ribeiro Fernandes, M., Granja Arakaki, D., Freitas, K. D. C., Avellaneda Guimaraes, R. D. C. and Aiko Hiane, P. (2018). An overview of novel dietary supplements and food ingredients in patients with metabolic syndrome and non-alcoholic fatty liver disease. *Molecules*, *23*(4), 877.

Soetan, K. O., Olaiya, C. O., & Oyewole, O. E. (2010). The importance of mineral elements for humans, domestic animals and plants: A review. *African journal of food science*, *4*(5), 200-222.

Thoppil, R. J., & Bishayee, A. (2011). Terpenoids as potential chemopreventive and therapeutic agents in liver cancer. *World Journal of Hepatology*, 3(9), 228-249.

Ulloa, J. A. (2023). Valorization of the Noni (Morinda citrifolia) seeds as source of a protein concentrate and its physicochemical, functional, and structural characterization. Waste and Biomass Valorization, 14, 2270.

Usha, R., Sashidharan, S., & Palaniswamy, M. (2010). Antimicrobial activity of a rarely known species, *Morinda citrifolia* L. *Ethnobotanical Leaflets*, *14*, 306-311

Wang, M. Y., West, B. J., Jensen, C. J., Nowicki, D., Su, C., Palu, A. K., & Anderson, G. (2002). *Morinda citrifolia* (Noni): A literature review and recent advances in Noni research. *Acta Pharmacologica Sinica*, 23(12), 1127-1141.

You, C., Awang, S.R. & Wu, Y. (2024). Bibliometric analysis of global research trends on higher education leadership development using Scopus database from 2013–2023. *Discov. Sustain.*, 5, 246, https://doi.org/10.1007/s43621-024-00432-x

Zhang, W., Lu, C., Cai, S., Feng, Y., Shan, J., & Di, L. (2022). Aconiti lateralis radix praeparata as potential anticancer herb: Bioactive compounds and molecular mechanisms. *Frontiers in pharmacology*, *13*, 870282.

Zhang, X., Zhao, W., Wang, Y., Lu, J., & Chen, X. (2011). The chemical and pharmacological properties of alkaloids from *Morinda citrifolia*. *Journal of Medicinal Plants Research*, 5(14), 3092-3098.