Acta Scientiarum

http://periodicos.uem.br/ojs/
ISSN on-line: 1807-863X
Doi: 10.4025/actascibiolsci.v47i1.72905

REVIEW

Orthosiphon stamineus Benth. (Lamiaceae): a bibliometric analysis of its antidiabetic properties

Nneka Augustina Akwu[1*], Folasade Banji-Onisile[2], Adeoye John Kayode[3], Unarine Rambau[4], Melisa Mendez[5], Ijeoma Nnadozie[6], Arif Nur Muhammad Ansori[7] and Hery Purnobasuki[7*]

[1]Indigenous Knowledge Systems Centre, Faculty of Natural and Agricultural Sciences, North-West University, Mmabatho, Mmabatho Unit 5, Mahikeng, 2790, South Africa. [2]Department of Microbiology, School of Life Sciences, University of KwaZulu-Natal, Durban, South Africa. [3]Department of Biochemistry, Genetics and Microbiology, University of Pretoria, Hatfield, Pretoria, South Africa. [4]Department of Biological Sciences, Faculty of Science, Engineering and Agriculture, University of Venda, Thohoyandou, South Africa. [5]Applied Life Sciences, Keck Graduate Institute, Claremont, California, United State of America. [6]Human Genetics and Genomic Data Analysis, Claremont, California, United State of America. [7]Departemen Biologi, Fakultas Sains dan Teknologi, Universitas Airlangga, Surabaya, Indonésia. *Authors for correspondence. E-mail: hery-p@fst.unair.ac.id; nneka.akwu@yahoo.com

ABSTRACT. The use of medicinal plants for the management of diabetes is gaining rapid attention. There are several reports on the antidiabetic properties of *Orthosiphon stamineus* Benth. There has been no previous bibliometric analysis review conducted on *O. stamineus* as an antidiabetic agent to date. Therefore, this review is centred on gathering information about the potential sources of antidiabetic properties from *O. stamineus*. A bibliometric analysis on the antidiabetic properties of *O. stamineus* was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Scientific publications in the SCOPUS database were retrieved using the search strings 'Orthosiphon stamineus' OR '*Orthosiphon aristatus*' OR '*Kumis Kucing*' OR 'Misai Kucing' OR 'Java tea' AND 'diabetes' OR 'diabetes mellitus' OR 'dm' OR 'antidiabetic' OR 'hypoglycemic' OR 'diabetic complications' OR 'insulin' OR 'glucose'. 76 articles related to *O. stamineus* and diabetes were included after the exclusion criteria. The bibliometric analysis spanning from 1991 and 2023 sheds light on the dynamic and collaborative research landscape surrounding *O.stamineus*. It highlights several aspects of the plant's multifaceted exploration for potential antidiabetic properties, including a surge in activity in 2006 and 2012, international contributions, a diverse distribution across journals, and a broad spectrum of keyword concepts.

Keywords: hypoglycemia; Indonesia; medicinal plants; *Orthosiphon aristatus*; Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA); Sustainable Development Goals (SDG).

Received on July 12, 2024
Accepted on January 10 2025

Introduction

Orthosiphon stamineus Benth. (*Orthosiphon aristatus* Blume Miq) is commonly called cat's whiskers or Java tea and known as 'Kumis Kucing' (Indonesian) and 'Misai Kucing' (Malaysian) (Gimbun et al., 2019; Silalahi, 2019; Hartanti & Budipramana, 2020). It belongs to the Lamiaceae family which is known to be aromatic with medicinal and culinary uses amongst other uses. In Indonesia, Malaysia, Thailand, and southern China (Vietnam and Myanmar), it is traditionally used for the treatment of chronic renal failure and diabetes (Adnyana et al., 2013; Kyaw et al., 2021; Maulana et al., 2022; Wang et al., 2022). Diabetes is a chronic disease that affects the endocrine system resulting in high blood sugar levels usually linked to other metabolic syndromes such as hypertension and obesity. It has expanded far and now affects millions of individuals worldwide (Jyotsna et al., 2023). About 463 million adults between the ages of 20 and 79 had diabetes in 2019, and the International Diabetes Federation (IDF) projects that figure to reach 700 million by 2045 (Jyotsna et al., 2023). Diabetes not only results in elevated blood glucose levels but also presents with several chronic complications that significantly impact the health and overall quality of life of those who have it. The fact that diabetes might result in cardiovascular disease is one of the most concerning. For those with diabetes, cardiovascular diseases such as heart failure, stroke, and coronary artery disease are leading causes of death and disability (Jyotsna et al., 2023).

Three major diabetic conditions have been identified including type 1, type 2, and gestational diabetes. Type 2 and gestational Diabetes Mellitus are reversible, unlike type 1 diabetes which could have a genetic undertone and is not often reversible but managed through lifestyle modifications (Standl et al., 2019).

Diabetes is a global health concern that requires extensive research to investigate possible treatment options. According to literature, *Orthosiphon stamineus* has antimicrobial, cytotoxic, hypouricemic,

antioxidant, hepatoprotective, anorexic, renal protective, antihyperlipidemic, antigenotoxic, diuretic, antiplasmodial, antihypertensive, antidiabetic, gastroprotective, antiviral, anti-inflammatory activities (Ashraf et al., 2020; To et al., 2020; Yeong & Chin, 2021; Wang et al., 2022; Ahda et al., 2023). It is rich in eupatorine, rosmarinic acid, and sinensetin (Hernadi et al., 2019; Li et al., 2019; Faramayuda et al., 2021). The hypoglycemia properties of *O. stamineus* may be due to the presence of certain flavonoids, terpenoids, phenolic acids, essential oils and triterpenoids (Ashraf et al., 2020; Wang et al., 2022).

The main mechanisms through which *O. stamineus* mitigates diabetes and its complications include the inhibition of α-amylase and α-glucosidase activities, antioxidative and anti-inflammatory activities, regulation of lipid metabolism, enhancement of insulin secretion, amelioration of insulin resistance, increased glucose uptake, promotion of glycolysis, inhibition of gluconeogenesis, stimulation of glucagon-like peptide-1 (GLP-1) secretion, and antiglycation activity (Wang et al., 2022). However, the antidiabetic mechanism of *O. stamineus* remains not fully understood (Bassalat et al., 2023). Other species of the *Orthosiphon* genus of the Lamiaceae family, *O. aristatus* (*O. stamineus*), *O. pallidus*, and *O. thymiflorus* hold significance in traditional medicine. These species are commonly employed to mitigate various conditions, including but not limited to diabetes, rheumatism, hepatitis, hypertension, jaundice, kidney stones, and edema (Wang et al., 2022; Abirami et al., 2023; Subbiah et al., 2023).

There are reports on the ethnopharmacology, preclinical and clinical applications of *Orthosiphon stamineus* (Adnyana et al., 2013; Bokhari et al., 2018; Samidurai et al., 2019; Alshehade et al., 2022). A systematic review was conducted to assess the impact of *O. stamineus* in managing diabetes, its associated complications. Nevertheless, the findings emphasized the necessity for extensive research concerning the pharmacodynamic substance basis and the mechanisms of the constituents that contribute to the substance effectiveness (Wang et al., 2022).

Despite its frequent utilization in diabetes management, there is a lack of quantitative assessment within the existing literature concerning *Orthosiphon stamineus*. This gap underscores the need for a comprehensive overview of the global research landscape connecting *O. stamineus* and diabetes, thereby contextualizing this study within the broader literature. This review adopts a quantitative approach through bibliometric analysis to evaluate scientific research publications. The aim is to uncover trends, patterns, and the growth trajectory of research in this field, encompassing factors like publication count, authors, journals, and citation counts. This analysis seeks to highlight influential studies and authors, thereby aiding in the identification of key research gaps and potential collaborative opportunities. Additionally, the review aims to pinpoint the most frequently explored aspect of *O. stamineus,* including active components, mechanism of action, and specific diabetes-related complications targeted.

Material and methods

Search strategy: Data collection and analysis

The Scopus database was used to gather relevant scientific publications using the search terms '*Orthosiphon stamineus*' OR '*Orthosiphon aristatus*' OR 'Kumis Kucing' OR 'Misai Kucing' OR 'Java tea' AND 'diabetes' OR 'diabetes mellitus' OR 'dm' OR 'antidiabetic' OR 'hypoglycemic' OR 'diabetic complications' OR 'insulin' OR 'glucose'. Scopus was the only database accessed because it is more extensive, comprehensive and covers a wide range of scientific literature (Pranckutė, 2021). The inclusion criteria were publications in peer-reviewed journals that specifically investigated the antidiabetic properties of *O. stamineus,* while for the exclusion criteria studies that are not related to the antidiabetic properties of *O. stamineus* were excluded. In addition, non-peer-reviewed articles and conference abstracts were excluded based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). Thereafter, the bibliometric analysis was conducted to evaluate the research trends on the antidiabetic properties of *O. stamineus* using R-based Biblioshiny application and Vos Viewer (Eck & Waltman, 2014).

Results and discussion

Main information

Ninety-eight documents were identified from the Scopus database. After applying exclusion criteria, 76 studies were included for the bibliometric analysis. The exclusion criteria removed 22 records which were either reviews, systematic reviews, conference proceedings, or books. No duplicate records were identified

(Figure 1). From 1991 to 2023, a total of 327 authors contributed to 76 documents with 248 distinct author's keywords, drawing from 60 sources and generating 2828 references. Single-authored documents were written by one individual, whereas international co-authorship was present in 17.11% of the documents. The average age of the documents was 7.91 years, reflecting an annual growth rate of 4.43%. Co-authors per document averaged 5.21, and the average number of citations per document was 21.47.

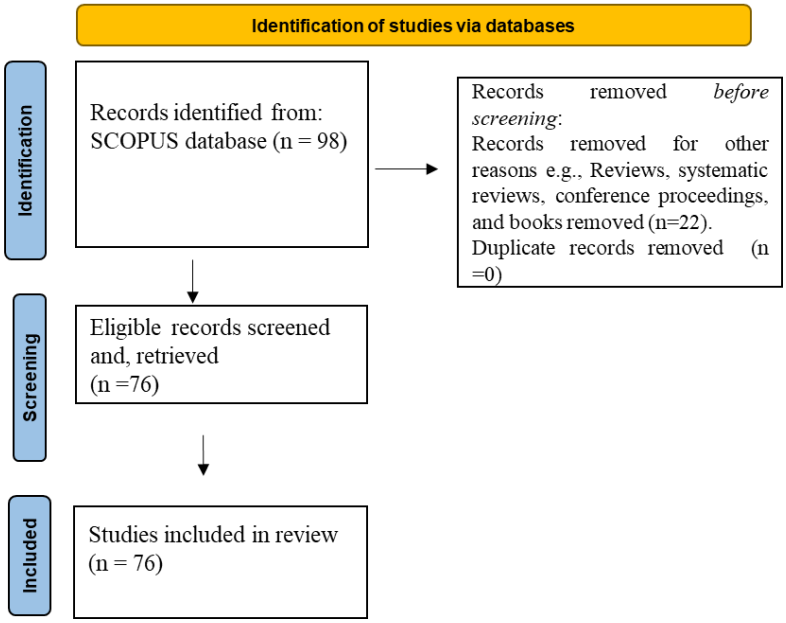

Figure 1. A methodological flow diagram for study inclusion of data collection and filtering process using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement on the antidiabetic properties of *Orthosiphon stamineus*.

Publication trends

Distribution of publications: Total publications, citations per article and year

The peaks and troughs in 'MeanTCperArticle and MeanTCperYear' indicate varied scholarly impact or interest at various times (years). The pattern fluctuates over the years, with certain years, such as 1991, 2012, and 2013, showing higher values, while other years, like 2016 and 2022, exhibit lower values (Figure 2). The notable surge in the research activity from 2006 - 2016 may be attributed to increased interest and awareness among researchers, advancements in research techniques, and promising results indicating potential therapeutic benefits of *O. stamineus* in managing diabetes, with the highest number of publications in 2015 (12 publications) (Figure 2).

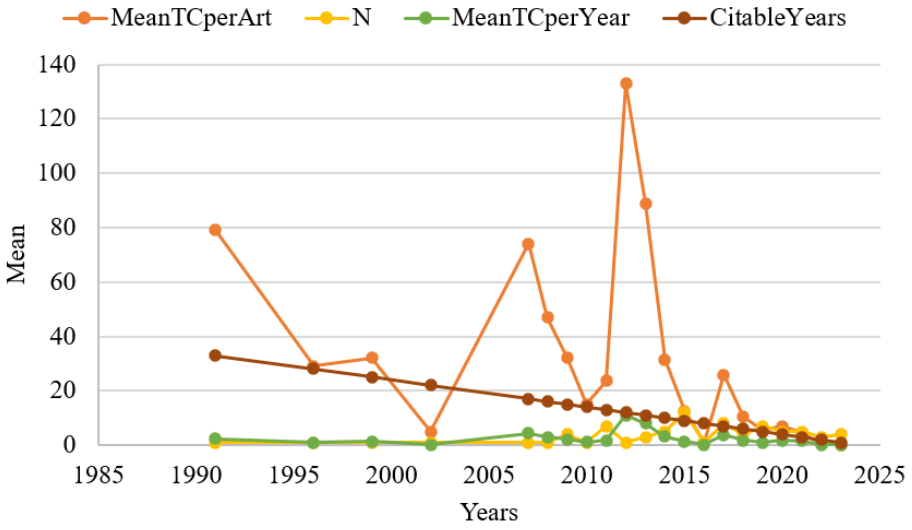

Figure 2. The annual (1991-2023) total citation of scientific publications per year on the antidiabetic properties of *Orthosiphon stamineus*. TC: Total citation and N=Number.

Journal analysis

This publication surge aligns with the broader context of global age-standardized adult diabetes prevalence, which increased from 4.3 to 9.0% in men and from 5.0 to 7.9% in women between 1980 and 2014 from individuals in these regions: central Africa, Asia Pacific, sub-Saharan Africa, Caribbean, central Europe, central Asia, and other regions (NCD Risk Factor Collaboration [NCD-RisC], 2016). Posterior probabilities of 0.994 for men and 0.954 for women further suggest likely genuine increases during this period (NCD-RisC, 2016). NCD-RisC (2016) further reported that from 1980 to 2014, no country experienced a statistically significant reduction in diabetes prevalence. However, the relative increase over this 35-year period was less than 20% in nine countries for men, primarily in northwestern Europe, and in 39 countries for women.

Most publishing Journals

The distribution of articles across different journals is indicative of the heterogeneous and multidisciplinary character of investigations about the antidiabetic characteristics of *Orthosiphon stamineus* (Figure 3). In 2006 and 2012, there was a significant increase in research activity, indicating increased interest and awareness among researchers. The Journal of Ethnopharmacology is the leading publication for research in this field, with nine published articles out of most publications published there. The Asian Journal of Pharmaceutical and Clinical Research, BMC Complementary and Alternative Medicine, Molecules, Biomed Research International, and the Journal of Complementary and Alternative Medicine are other prominent journals that have published three or more articles. The variety of other scientific journals that publish this research, including Planta Medica, Evidence-Based Complementary and Alternative Medicine, and Chemical and Pharmaceutical Bulletin, among others, shows how widely this research is disseminated. This varied distribution among journals points to the incorporation of different viewpoints, approaches, and scientific communities in diabetes management.

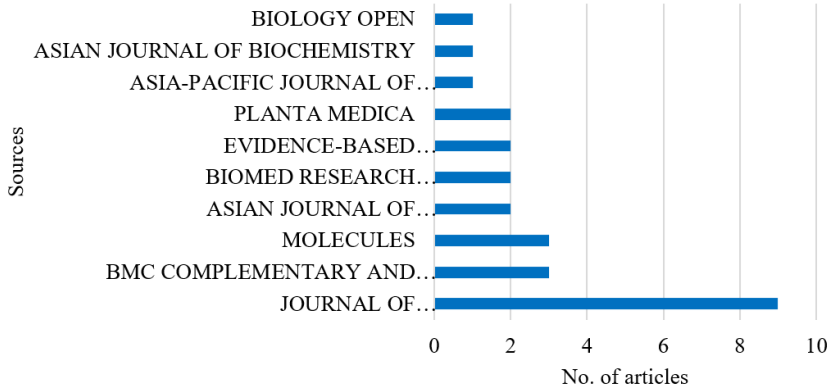

Figure. 3. The most relevant sources of publications on the antidiabetic properties of *Orthosiphon stamineus*.

Geographical distribution of research

Country production

The distribution of research output among these countries highlights the global cooperation and joint endeavors in exploring *O. stamineus's* potential as an antidiabetic agent. The information shows that there is a worldwide dedication to increasing knowledge in this area, with some regions standing out as major producers of the body of scientific literature (Figure 4).

Malaysia leads scientific contributions with noteworthy commitment, presenting 204 publications frequency on the antidiabetic properties of *O. stamineus.* Following closely in this field, is Indonesia having published frequency of 44 articles with 29 publications, India stands out as a country that is actively involved, while Indonesia is a close second, with 44 articles indicating active research in this field. Thailand exhibits significant interest with 28 publications, while India stands out with 29 publications highlighting its active involvement. With 19 papers, Brazil makes a large contribution and is well-represented in this field of research. Together, East Asian nations including China, South Korea, and Japan contribute to the investigation of *O. stamineus* for anti-diabetic uses. Germany, the Netherlands, Australia, and Israel all make little contributions to the global conversation. Other collaborators, though less in number, from countries

including Iraq, USA, Myanmar, and Mauritius, demonstrate a diversified global participation in the investigation of *O. stamineus's* antidiabetic effects.

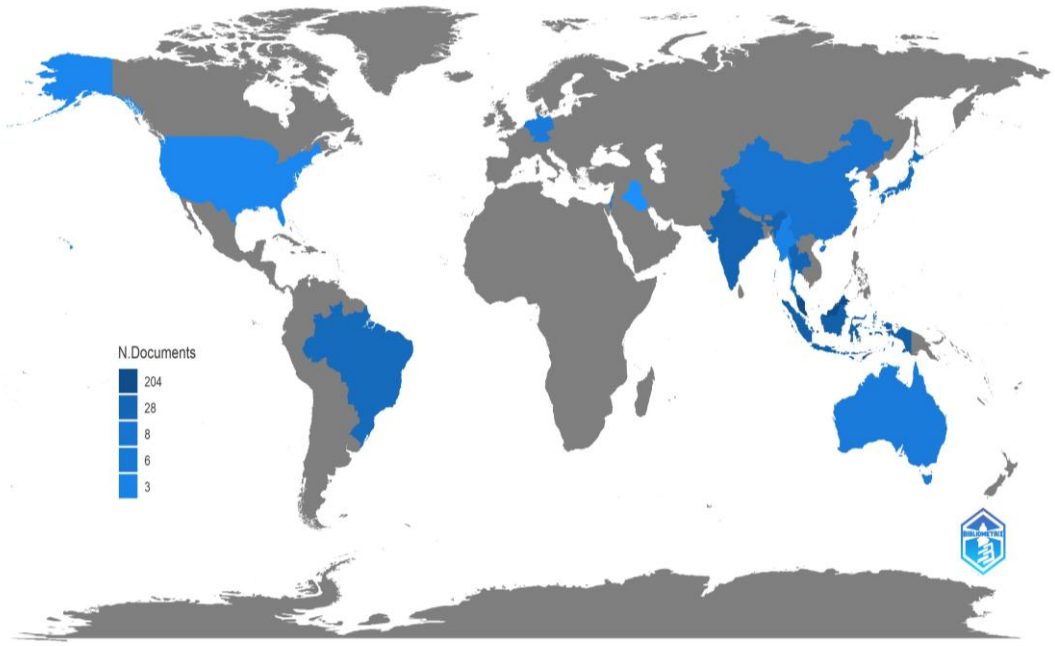

Figure 4. Scientific production of publications on the antidiabetic properties of *Orthosiphon stamineus* worldwide.

Country collaboration

Figure 5 provides insights into the varied network of cooperative activities among these nations (China, Myanmar, Indonesia, Netherlands, Malaysia, Australia, Brazil, India, Iraq, Thailand, USA, and Japan) and offers insights into international partnerships forged in investigating the antidiabetic potential of *O. stamineus*. The notable collaborations are between Malaysia and Australia, as well as between Indonesia and the Netherlands both having a frequency of two each. Additionally, Malaysia collaborated once with the USA, Thailand, India, Iraq, Brazil, and Thailand. Furthermore, collaboration existed between China and Myanmar, Indonesia and Japan, Thailand and Japan, and Thailand and the United States of America.

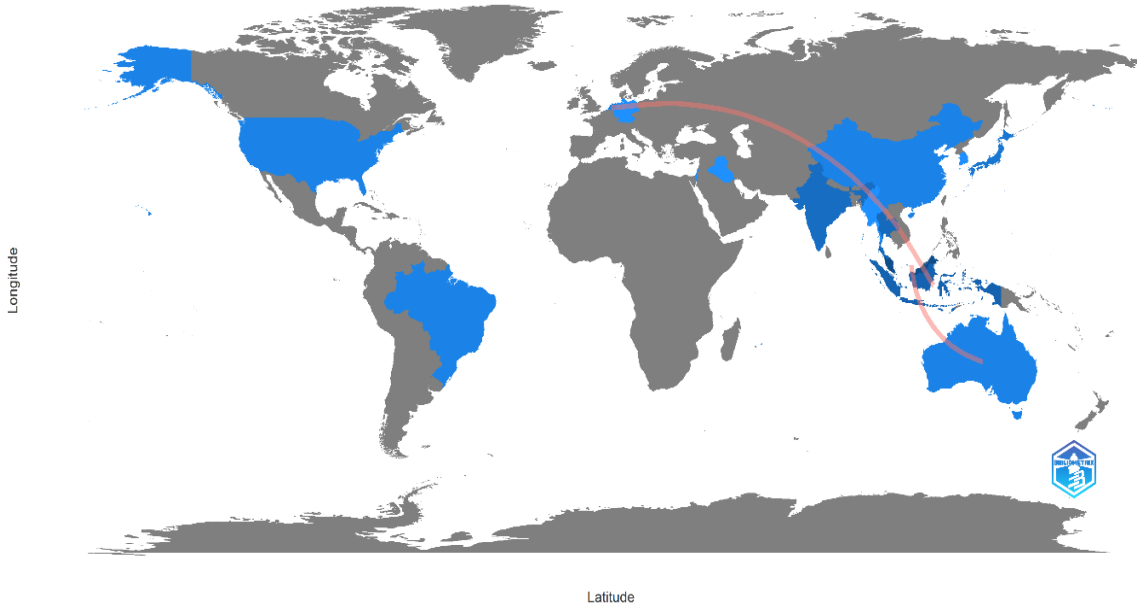

Figure 5. Country collaboration map of publications frequency on the antidiabetic properties of *Orthosiphon stamineus*.

Figure 5 also highlights international collaboration, with significant contributions from Malaysia, Indonesia, India, and Thailand, emphasizing the global commitment to advancing knowledge in this area.

Publications keyword

Common keywords used in publications

The keyword analysis reveals a variety of concepts and methodologies investigated in the publications, with a focus on chemical characterization, diabetes management, and ethnobotanical aspects. The larger words (i.e. keywords) in Figure 6, represent terms that are more frequently used in research on the antidiabetic properties of *O. stamineus*. This implies that the publications encompass a diverse array of concepts and methodologies, with words like 'article', '*Orthosiphon*', and 'plant extract', being the most frequent suggest that the general characterization of *O. stamineus* and its components is given a great deal of attention. Terminologies such as 'diabetes mellitus', 'antidiabetic activity', and 'antidiabetic agent' emphasize the primary focus on investigating *O. stamineus's* possible therapeutic benefits in the treatment of diabetes. Notably, words like 'ethnobotany', 'traditional medicine', and 'phytotherapy' underscore the contextualization of *O. stamineus* within herbal and customary medicine. Terms such as 'chemistry', 'enzyme inhibition', and 'high-performance liquid chromatography' indicate that the chemical and biochemical properties of *O. stamineus*, and especially its bioactive components, are of great interest. The frequency of phrases pertaining to experimental procedures, such as 'animal experiment', 'controlled study', and 'Sprague Dawley rat', suggests a significant amount of preclinical development.

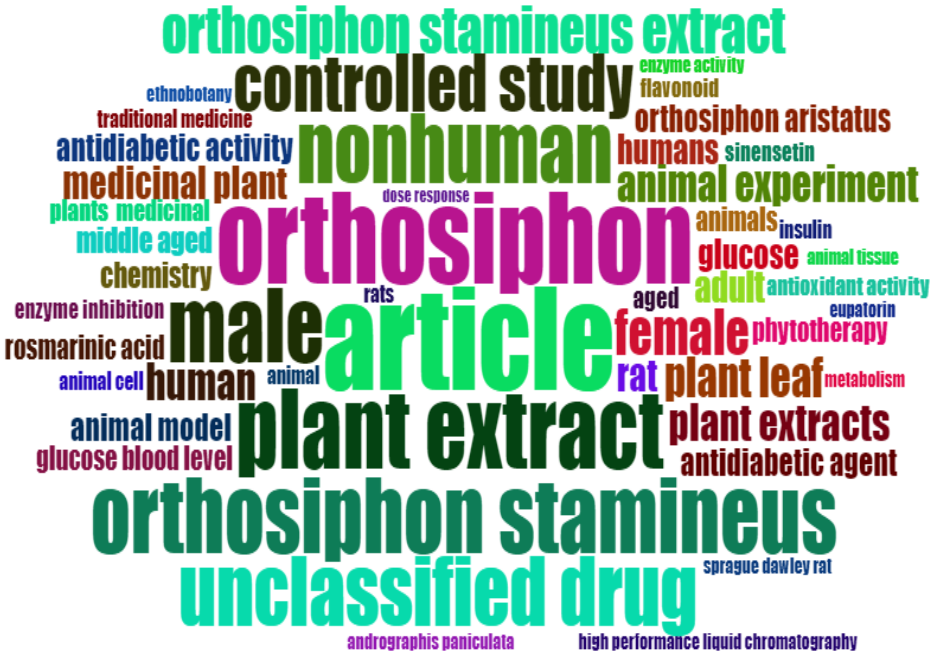

Figure 6. Word cloud of publications on the antidiabetic properties of *Orthosiphon stamineus*.

Co-occurrence of authors keywords

A total of 248 keywords were identified and analyzed with a minimum occurrence threshold set at 2; 33 keywords met this criterion. Figure 7 illustrates the evolving research focus, showing that in 2010, emphasis was placed on *Andrographis paniculate.* Subsequently, around 2013, there was a notable shift to *O. stamineus*.

Between 2013 and 2015, *O. stamineus* (also known as *Orhosiphon aristatus*) from the family Lamiaceae (Figure 7) was explored not only for diabetes treatment but also for antioxidant activity and α-glucosidase assay. Research extended to precise phytometabolites like rosmarinic acid, eupatorine, and sinensetin, covering diverse areas such as obesity, diuretic (java tea) properties, and ethnomedicine. Noteworthy findings include the mixed-type inhibition of CYP2C19 by eupatorine, derived from *O. stamineus* petroleum ether extract, with a significant inhibition constant Ki of 7.1 μg mL^{-1} or 20.6 μM (Pan et al., 2011). Despite these local medicinal plants like *Andrographis paniculata* and *O.stamineus*, traditionally used for healing, have seen recent commercialization (Malahubban et al., 2013). Additionally, herbal supplements from *O. stamineus* (cat's whiskers), such as Kumis Kucing AL AFIAT, Kumis Kucing TN 57, Kumis Kucing Deprostat Kaplet, have gained commercial success in Indonesia. From 2019 onwards, research has predominately focused on diabetes mellitus and associated assays (α-amylase), metabolomics, other medicinal plants, Non-alcoholic Fatty Liver Disease (NAFLD), caffeic acid, glut4 (an insulin-regulated glucose transporter), various phytochemicals, and total phenolic content.

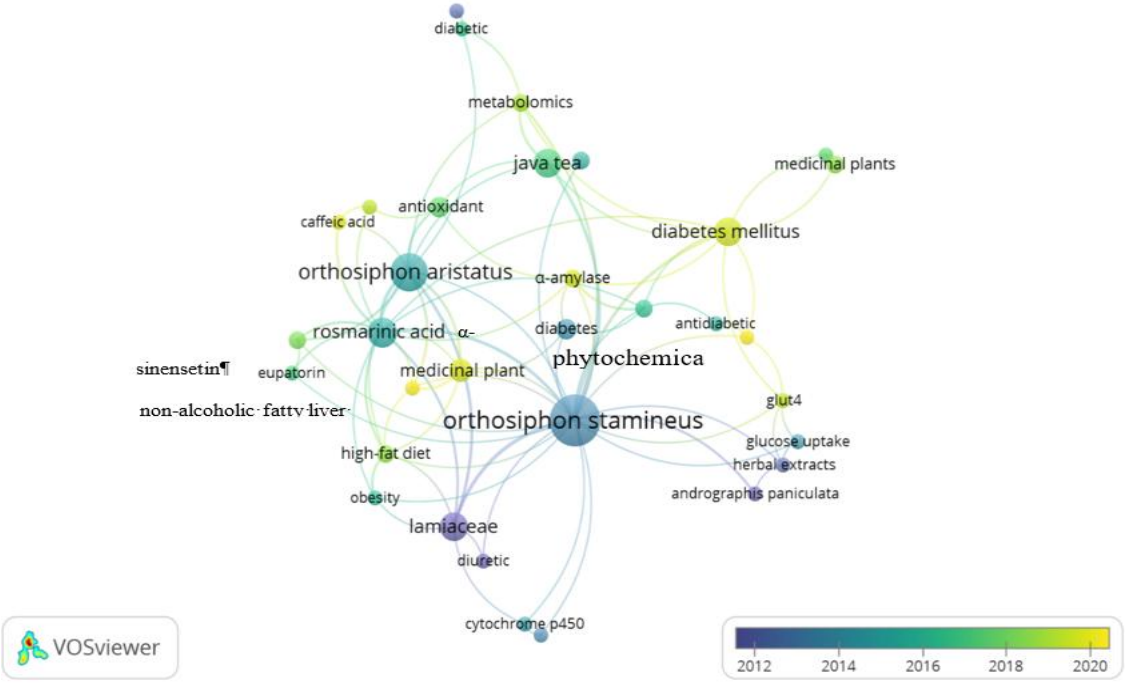

Figure 7. The co-occurrence of authors' keywords (overlay visualisation) on the antidiabetic properties of *Orthosiphon stamineus*.

Conceptual structure map

The conceptual structure map is based on key terms analysis (Figure 8), which measured the proximity of variables i.e. authors' keywords and their connection, which gives insights into the clusters of articles that have common concepts. A mapping between words whose values did not differ significantly is produced by placing each word in accordance with the values of Dim 1 and Dim 2. Dim is a specific term in bibliometric science, it stands for the quantity of authors who, during a given period, have only published one paper in a particular field or journal. The results show that the focus of researchers is in two clusters; highlighted in red (heterogenous research terms) and blue (mainly *in vivo* research) (Figure 8). The top three most often occurring words in this region were '*Orthosiphon*', 'plant extracts', and '*Orthosiphon stamineus*'.

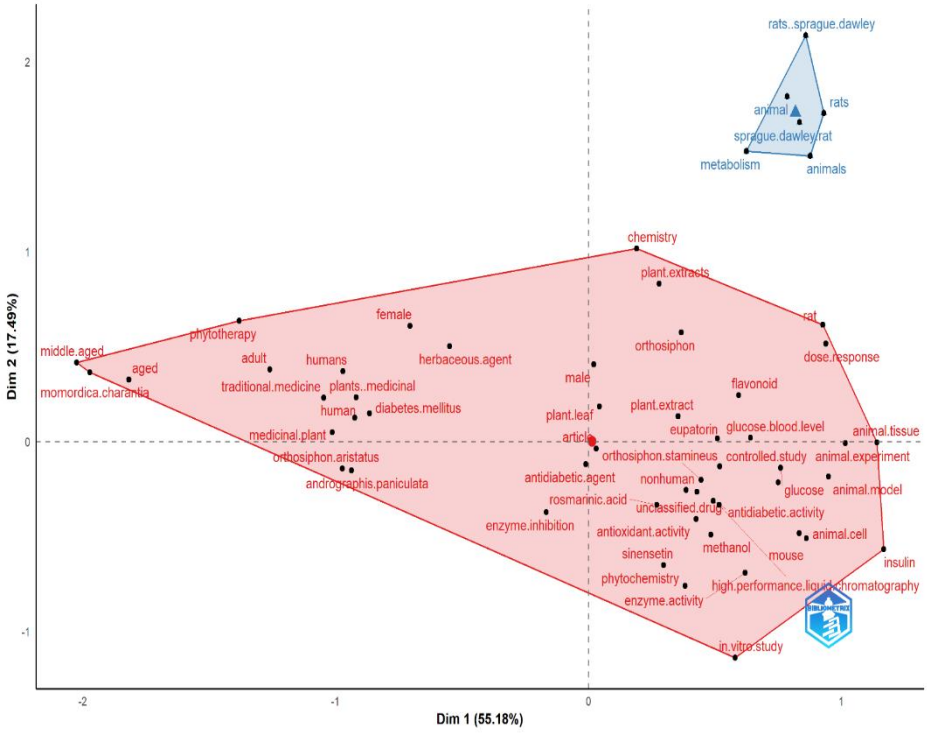

Figure 8. Conceptual structure map-method: MCA based on the publications on the antidiabetic properties of *Orthosiphon stamineus*.

Topic trend

The topic frequency trends show a dynamic and diverse research environment, with a continued focus on the basic science of *Orthosiphon stamineus* and an increasing attention to its possible uses in chemical characterization, diabetes treatment, and ethnobotanical settings (Figure 9). In addition, the use of phrases like 'flavonoids', 'plant extracts', 'eupatorin', and 'rosmarinic acid' indicates a continued curiosity about the chemical makeup of *O. stamineus* and its possible medical uses. From 2010 to 2017, the terms '*Orthosiphon*' and '*O.n stamineus*' showed a consistent rise in frequency, suggesting continued interest and research efforts towards the comprehensive characterization and investigation of this plant. Investigations into the possible antidiabetic benefits of *O. stamineus* are becoming more and more important, as seen by the rise in frequency of specific themes like 'diabetes mellitus' between 2015 and 2020. Phrases associated with experimental design such as 'rat', 'dose response', and 'rats' show different patterns and imply changes in the emphasis and approach of experiments across time. Terms such as 'chemistry', 'metabolism', 'high-performance liquid chromatography', and 'phytotherapy' have been more common in recent years, indicating that researchers studying diabetes are focusing more on the pharmacological and biochemical properties of *O. stamineus*. The increasing frequency of phrases like 'traditional medicine', '*O. aristatus*', '*Senna alata*', and 'ethnobotany' in recent years also indicates a growing interest in traditional and ethnobotanical features, according to the data. This suggests a more thorough investigation of the plant in relation to customary and cultural uses for medicine.

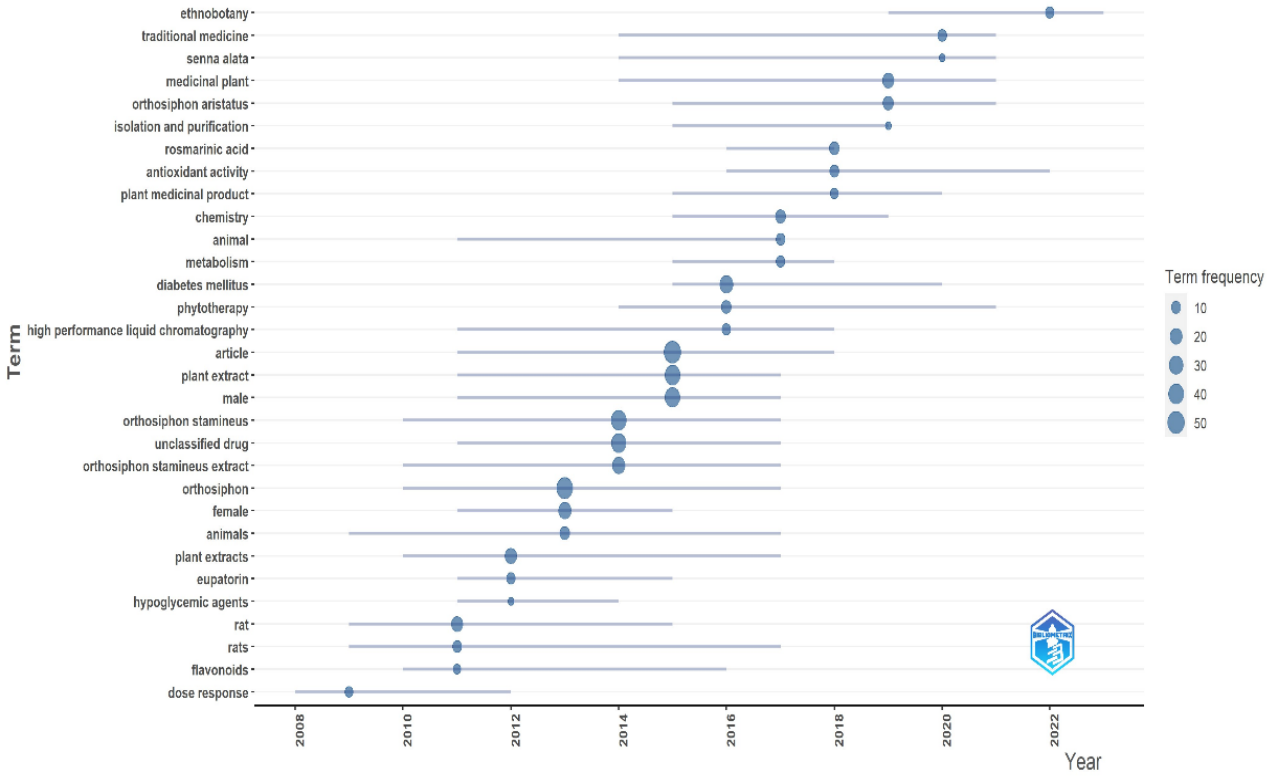

Figure 9. The trend topics of publications on the antidiabetic properties of *Orthosiphon stamineus*.

Conclusion

This bibliometric analysis (1991-2023) highlights the collaborative research landscape of *Orthosiphon stamineus*, involving 327 authors across 60 sources and citing 2,828 references. Research activity peaked between 2006 and 2016, driven by increased interest, advanced methods, and promising anti-diabetic potential. Malaysia leads in contributions, followed by Indonesia and India, emphasizing international collaboration. Keyword analysis reveals focus areas like chemical characterization, diabetes management, and ethnobotany. The study underscores the need for further research on pharmacodynamic compounds and mechanisms. Aligning with SDGs 3, 9, and 17, this review highlights influential authors, journals, and directions in exploring *O. stamineus*' therapeutic potential.

References

Abirami, K., Revathi, P., Krishnasamy, T., & Sowndhararajan, K. (2023). Comprehensive Review on Wild Basil Genus *Orthosiphon* of Lamiaceae. *Bioprospecting of Tropical Medicinal Plants,* 409-426. https://doi.org/10.1007/978-3-031-28780-0_15

Adnyana, I. K., Setiawan, F., & Insanu, M. (2013). From ethnopharmacology to clinical study of *Orthosiphon stamineus* Benth. *International Journal of Pharmacy and Pharmaceutical Sciences, 5*(3), 66-73.

Ahda, M., Jaswir, I., Khatib, A., Ahmed, Q. U., Mahfudh, N., Ardini, Y. D., Syed Mohamad, S. N. A. S., Anwar, M., Hernawan, H., Miyashita, K., & Salamatullah, A. M. (2023). Phytochemical analysis, antioxidant, α-glucosidase inhibitory activity, and toxicity evaluation of *Orthosiphon stamineus* leaf extract. *Scientific Reports, 13*(1), 17012. https://doi.org/10.1038/s41598-023-43251-2

Alshehade, S. A., Al Zarzour, R. H., Murugaiyah, V., Lim, S. Y. M., El-Refae, H. G., & Alshawsh, M. A. (2022). Mechanism of action of *Orthosiphon stamineus* against non-alcoholic fatty liver disease: Insights from systems pharmacology and molecular docking approaches. *Saudi Pharmaceutical Journal, 30*(11), 1572-1588. https://doi.org/10.1016/j.jsps.2022.09.001

Ashraf, K., Halim, H., Lim, S. M., Ramasamy, K., & Sultan, S. (2020). *In vitro* antioxidant, antimicrobial and antiproliferative studies of four different extracts of *Orthosiphon stamineus, Gynura procumbens* and *Ficus deltoidea*. *Saudi Journal of Biological Sciences, 27*(1), 417-432. https://doi.org/10.1016/j.sjbs.2019.11.003

Bassalat, N., Kadan, S., Melamed, S., Yaron, T., Tietel, Z., Karam, D., Kmail, A., Masalha, M., & Zaid, H. (2023). *In vivo* and *in vitro* antidiabetic efficacy of aqueous and methanolic extracts of *Orthosiphon stamineus Benth. Pharmaceutics, 15*(3), 945. https://doi.org/10.3390/pharmaceutics15030945

Bokhari, R. A., Tantowi, N. A. C. A., Lau, S. F., & Mohamed, S. (2018). Java Tea (*Orthosiphon stamineus)* protected against osteoarthritis by mitigating inflammation and cartilage degradation: a preclinical study. *Inflammopharmacology, 26*(4), 939-949. https://doi.org/10.1007/s10787-017-0432-2

Eck, N. J. van, & Waltman, L. (2014). Visualizing bibliometric networks. In Y, Ding, R. Rousseau, & D. Wolfram. *Measuring Scholarly Impact. Methods and Practice* (pp. 285-320). Springer.

Faramayuda, F., Mariani, T. S., Elfahmi, E., & Sukrasno, S. (2021). Potential of *Orthosiphon aristatus* Blume Miq as antiviral: a review. *Tropical Journal of Natural Product Research, 5*(3)*,* 410-419. https://doi.org/10.26538/tjnpr/v5i3.1

Gimbun, J., Pang, S. F., & Yusoff, M. M. (2019). *Orthosiphon stamineus* (java tea). In S. M. Navabi, & A. S. Silva. *Nonvitamin and Nonmineral Nutritional Supplements* (pp. 327-333). Elsevier.

Hartanti, D., & Budipramana, K. (2020). Traditional antidiabetic plants from Indonesia. *Ethnobotany Research & Applications, 19*, 1-24. https://ethnobotanyjournal.org/index.php/era/article/view/1693

Hernadi, E., Rohaeti, E., Rafi, M., Wahyuni, W. T., Putri, S. P., & Fukusaki, E. (2019). HPLC fingerprinting coupled with linear discriminant analysis for the detection of adulteration in Orthosiphon aristatus. *Journal of Liquid Chromatography & Related Technologies, 42*(15-16), 513-520.

Jyotsna, F. N. U., Ahmed, A., Kumar, K., Kaur, P., Chaudhary, M. H., Kumar, S., Khan, E., Khanam, B., Shah, S. U., Varrassi, G., Khatri, M., Kumar, S., & Kakadiya, K. A. (2023). Exploring the complex connection between diabetes and cardiovascular disease: analyzing approaches to mitigate cardiovascular risk in patients with diabetes. *Cureus, 15*(8), e43882. https://doi.org/10.7759/cureus.43882

Kyaw, Y. M. M., Bi, Y., Oo, T. N., & Yang, X. (2021). Traditional medicinal plants used by the Mon people in Myanmar. *Journal of Ethnopharmacology, 265*, 113253. https://doi.org/10.1016/j.jep.2020.113253

Li, L., Chen, Y., Feng, X., Yin, J., Li, S., Sun, Y., & Zhang, L. (2019). Identification of metabolites of eupatorin *in vivo* and *in vitro* based on UHPLC-Q-TOF-MS/MS. *Molecules, 24*(14), 2658. https://doi.org/10.3390/molecules24142658

Malahubban, M., Alimon, A. R., Sazili, A. Q., Fakurazi, S., & Zakry, F. A. (2013). Phytochemical analysis of *Andrographis paniculata* and *Orthosiphon stamineus* leaf extracts for their antibacterial and antioxidant potential. *Tropical Biomedicine, 30*(3), 467-480.

Maulana, F., Muhammad, A. A., Umar, A., Mahendra, F. R., Musthofa, M., & Nurcholis, W. (2022). Profiling metabolites through chemometric analysis in *Orthosiphon aristatus* extracts as α-glucosidase inhibitory activity and in silico molecular docking. *Indonesian Journal of Chemistry, 22*(2), 501-514. https://doi.org/10.22146/ijc.71334

NCD Risk Factor Collaboration [NCD-RisC]. (2016). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4· 4 million participants. *The Lancet, 387*(10027), 1513-1530.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *British Medical Journal, 372*(71). https://doi.org/10.1136/bmj.n71

Pan, Y., Abd-Rashid, B. A., Ismail, Z., Ismail, R., Mak, J. W., Pook, P. C., Er, H. M., & Ong, C. E. (2011). *In vitro* modulatory effects of *Andrographis paniculata*, *Centella asiatica* and *Orthosiphon stamineus* on cytochrome P450 2C19 (CYP2C19). *Journal of Ethnopharmacology, 133*(2), 881-887. https://doi.org/10.1016/j.jep.2010.11.026

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications, 9*(1), 12. https://doi.org/10.3390/publications9010012

Samidurai, D., Pandurangan, A. K., Krishnamoorthi, S. K., Perumal, M. K., & Raaman, N. (2019). Sinensetin isolated from *Orthosiphon aristatus* inhibits cell proliferation and induces apoptosis in hepatocellular carcinoma cells. *Process Biochemistry, 88*, 213-221. https://doi.org/10.1016/j.procbio.2019.09.031

Silalahi, M. (2019). *Orthosiphon stamineus* Benth (Uses and Bioactivities). *Indonesian Journal of Science and Education, 3*(1), 26-33. https://doi.org/10.31002/ijose.v3i1.729

Standl, E., Khunti, K., Hansen, T. B., & Schnell, O. (2019). The global epidemics of diabetes in the 21st century: current situation and perspectives. *European Journal of Preventive Cardiology, 26*(2), 7-14. https://doi.org/10.1177/2047487319881021

Subbiah, U., Ajith, A., & Subbiah, H. V. (2023). Molecular docking and dynamics simulation of *Orthosiphon stamineus* against SGLT1 and SGLT2. *Journal of Biomolecular Structure and Dynamics, 41*(23), 13663-13678. https://doi.org/10.1080/07391102.2023.2193984

To, D.-C., Hoang, D.-T., Tran, M.-H., Pham, M.-Q., Huynh, N.-T., & Nguyen, P.-H. (2020). PTP1B inhibitory flavonoids from *Orthosiphon stamineus* benth. and their growth inhibition on human breast cancer cells. *Natural Product Communications 15,* https://doi.org/10.1177/1934578X19899517.

Wang, Q., Wang, J., Li, N., Liu, J., Zhou, J., Zhuang, P., & Chen, H. (2022). A systematic review of *Orthosiphon stamineus* Benth. in the treatment of diabetes and its complications. *Molecules, 27*(2), 444. https://doi.dorg/10.3390/molecules27020444

Yeong, K. Y., & Chin, K. W. (2021). Neuroprotection with the functional herbs from the Lamiaceae Family. *Frontiers in Natural Product Chemistry, 8*, 173-212. https://doi.org/10.2174/9781681089379121080007