PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol x(x): xx–xx
https://doi.org/10.14719/pst.2136

HORIZON
e-Publishing Group
HePG

REVIEW ARTICLE

Centella asiatica (L.) Urb: A comprehensive bibliometric analysis of published studies between 1857 and 2022

Nazlahshaniza Shafin[1], Ninie Nadia Zulkipli[2], Shaida Fariza Sulaiman[3], Norsuhana Omar[1], Noorah Al-Sowayan[4], Rozaziana Ahmad[1*], Asma Hayati Ahmad[1], Zahiruddin Othman[5] & Rahimah Zakaria[1]

[1]Department of Physiology, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia
[2]School of Biomedicine, Faculty of Health Sciences, Universiti Sultan Zainal Abidin (UniSZA), 21300 Terengganu, Malaysia
[3]School of Pharmaceutical Sciences, Universiti Sains Malaysia, 11800 Minden, Pulau Pinang, Malaysia
[4]Department of Biology, College of Science, Qassim University, Saudi Arabia
[5]Department of Psychiatry, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia

*Email: drroza@usm.my

OPEN ACCESS

ARTICLE HISTORY

Received22 September 2022
Accepted: 09 January 2023

Available online
Version 1.0 : 22 February 2022

Check for updates

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS etc.
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

CITE THIS ARTICLE

Shafin N, Zulkipli N N, Sulaiman S F, Omar N, Sowayan N A, Ahmad R, Ahmad A H, Othman Z, ZakariaR. *Centella asiatica* (L.) Urb: A comprehensive bibliometric analysis of published studies between 1857 and 2022. Plant Science Today (Early Access). https://doi.org/10.14719/pst.2136

Abstract

Centella asiatica (L.) Urban *(C. asiatica)* is a medicinal plant that generates terpenes, phenols, vitamins, minerals, polyacetylene and fatty acids among other phyto-constituents. This review focuses on the bibliometric analysis of 1164 documents on *C. asiatica* that were retrieved from the Scopus database. Harzing Publish or Perish and VOSviewer were used for citation and network analyses. According to the bibliometric analysis, publications are on the rise, particularly in the fields of pharmacology, toxicology and pharmaceutics, medicine, biochemistry, genetics and molecular biology, agricultural and biological sciences, and chemistry. "Phytoremediation", "secondary metabolites", "*Andrographis paniculata*", and "cognitive impairment" are emerging areas for *C. asiatica* research. However, currently there is a lack of international collaboration in *C. asiatica* research among contributing countries. Researchers can utilise the findings cited in this reiew to locate potential collaborators, top authors, countries and documents.

Keywords

Centella asiatica; bibliometric analysis; Harzing's Publish or Perish; VOSviewer

Introduction

Centella asiatica (L.) Urban *(C. asiatica)* or *Hydrocotyle asiatica* L. is a member of the plant family *Apiaceae* (Umbelliferae). The species is stoloniferous, perennial, flowering, mildly aromatic, low-growing, creeping herbaceous plant with prostrate or semi-erect stems and nodal roots (1). Its reniform, shovel-shaped leaves emerge in rosettes at nodes (2) and this plant reproduces by seeds or runners (3). It is also known as *pegaga* in Malaysia, *pegagan* or *kaki kuda* in Indonesia, in India, *luei gong gen* or *tung chaim* in China, and Indian pennywort or *gotu kola* in Europe and United States (4). This plant is native to Asia, India and Oceania countries such as Malaysia, Indonesia, Thailand, China, Bangladesh, Sri Lanka, Northern Papua New Guinea, Australia, South America, South Africa and Madagascar (5).

C. asiatica is commonly eaten fresh as a raw vegetable (ulam and salad) or prepared as juice or tea among the locals in Malaysia, Indonesia and Thailand (6). It contains various phyto-constituents such as terpenes, phenols, vitamins, minerals, polyacetylene, and fatty acids, which contribute to its medicinal values (5). In addition, it has been used to treat a variety of conditions such as neurological, endocrine, skin, cardiovascular, diges-

tive, respiratory, gynaecological, rheumatoid and other diseases (7). Owing to its enormous therapeutic potential mainly derived from asiaticoside, asiatic acid, madecassoside, and madecassic acid, the demand for Centella herb is constantly expanding in the global herbal market and it is one among the 178 species of medicinal plants that are consumed in quantity > 100 MT per year in India (8).

C. asiatica has a variety of clinical and therapeutic properties. These can be beneficial in the form of being strong wound healing (9), antimicrobial (10), anti-inflammatory (11), antioxidant (12), anti-cancer (13), anti-diabetic (14), insecticidal (15), immunomodulatory (16), hepatoprotective (17), cardioprotective (18) and neuroprotective (19). Despite being one of the important medicinal herbs, there is a lack of systematic and chronological studies to show how *C. asiatica* research has progressed and evolved. Puttarak *et al*. (20) and Kongkaew *et al*. (21) published a systemic review and meta-analysis on the effects of *C. asiatica* on cognitive and mood-related outcomes, and its efficacy and safety, respectively. Yusof *et al*. (22) had published a systematic literature review on the use of *C. asiatica* among the Malay community. Despite these reviews, there have been no bibliometric or network visualization studies on *C. asiatica* literature. Therefore, this review aims to utilize bibliometric analysis and network visualization to determine the global trend of *C. asiatica* research concerning the research trends, most prominent authors and most cited papers, evolution in authors' keywords as well as research collaboration.

Materials and Methods

The data were retrieved on 19th July 2022 from the Scopus database. The following search query in the article title was used: "*Centella asiatica*" or *"C. asiatica"* or "*Hydrocotyle asiatica*" or *pegaga* or pennywort or "*gotu kola*" or *mandookaparni*. Data for 2023 (n = 1), retracted document (n=1) and the erratum (n = 13) were excluded to avoid incomplete data for the respective year and double counting, respectively.

A total of 1164 documents were extracted from the Scopus database in Microsoft Excel (.xlsx), Research Information systems (.ris) and Comma-separated values (.csv) format. The data in .ris and .csv format were analysed using Harzing's Publish or Perish and VOSviewer for descriptive and network analysis, respectively.

Results

Research Trends

A total of 1164 documents on *C. asiatica* were retrieved from a search carried out for documents published until 19th July 2022, with no specified starting year. The first traceable document from the Scopus database on *C. asiatica* was published in 1857. The number of documents started to increase from the mid-90s onwards. The highest productivity was observed in 2021 with 123 documents (Fig. 1).

The types of document included article (1024 or 88.0%), conference paper (69 or 5.9%), review article (45 or 3.9%), book chapter (13 or 1.1%), note (5 or 0.4%), letter (4 or 0.3%), short survey (2 or 0.2%), data paper (1 or 0.1%) and editorial (1 or 0.1%).

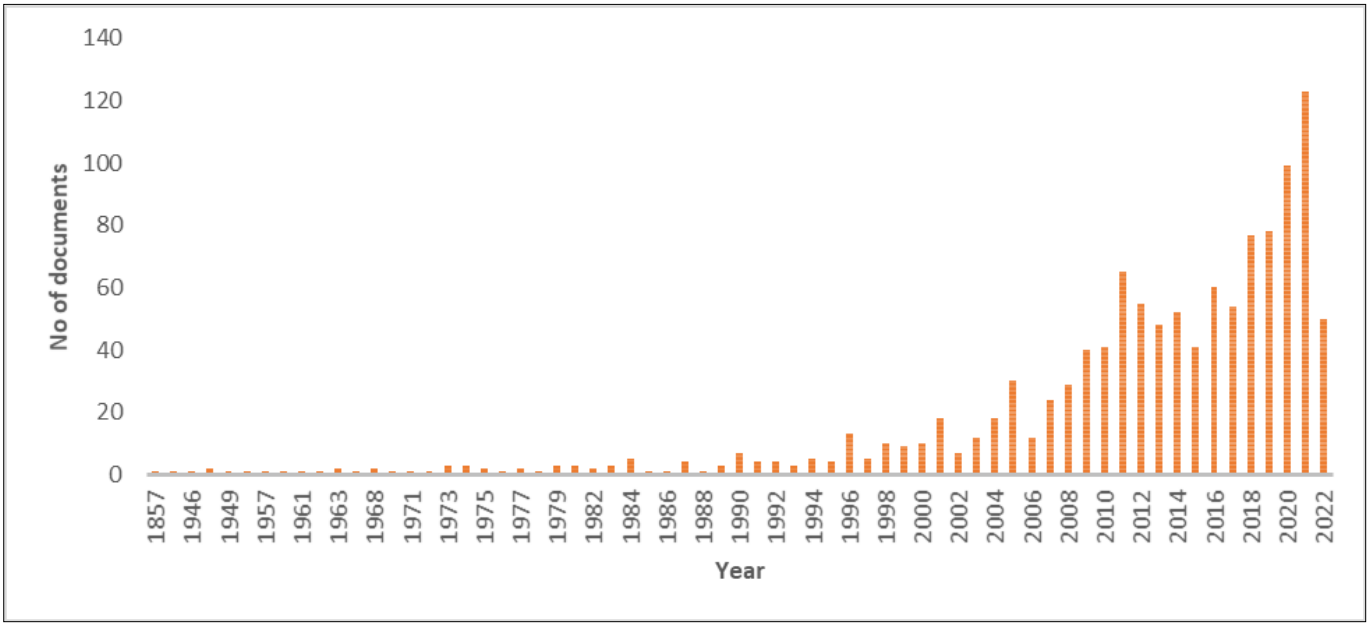


Fig. 1. The annual publications on *C. asiatica* from 1857 to 2020.

The majority of retrieved documents were published in English (1079, 92.4%), followed by French (22, 1.9%), Chinese (22, 1.9%), Italian (18, 1.5%) Spanish (7, 0.6%), Portuguese (6, 0.5%), Korean (4, 0.3%), German (3, 0.3%), Turkish (2, 0.2%) and others (5, .0.5%). Four of the documents were published in dual languages.

Prominent Authors

Table 1 shows the most authors ranked by total documents, detailing the number of citations, h-index and g-index. Belcaro G. from University of Studies G. d'Annunzio Chieti, Italy was the most productive author followed by Soumyanath A. from Oregon Health & Science University, the United States and Tantisira MH. from Burapha Univer-

Table 1. Most productive authors, institutions and countries (total documents > 10)

Author's name	Institution	Country	TD	TC	*h*	*g*
Belcaro G	University of Studies G. d'Annunzio Chieti	Italy	22	463 (3)	15 (1)	21 (1)
Tantisira MH	Burapha University	Thailand	20	388 (7)	11 (6)	19 (3)
Soumyanath A	Oregon Health & Science University	United States	20	605 (1)	12 (3)	20 (2)
Gray NE	Oregon Health & Science University	United States	16	425 (4)	10 (7)	16 (4)
Quinn JF	Oregon Health & Science University	United States	16	408 (5)	10 (8)	16 (5)
Cesarone MR	University of Studies G. d'Annunzio Chieti	Italy	15	399 (6)	14 (2)	15 (6)
De Sanctis MT	University of Studies G. d'Annunzio Chieti	Italy	12	349 (8)	12 (5)	12 (7)
Caruso M	Oregon Health & Science University	United States	12	175 (9)	8 (9)	12 (8)
Khotimah H	Brawijaya University, Malang	Indonesia	12	26 (10)	2 (10)	4 (10)
Kim OT	Rural Development Administration	South Korea	12	503 (2)	12 (4)	12 (9)

TD = total number of documents; TC = total citations; *h* = h-index; *g* = g-index., In parenthesis, ranking according to TC, *h* and *g* indices, respectively.

sity, Thailand. The top countries by author affiliation in Table 1 were the University of Studies G. d'Annunzio Chieti in Italy and Oregon Health & Science University in the United States.

Most Cited Papers

According to the Scopus database, the most cited article was a review article, "Chemical, pharmacological and clinical profile of the East Asian medical plant *Centella asiatica*" which appeared in Phytomedicine with 333 citations. The second-ranked article was an original article, "*In vitro* and *in vivo* wound healing activity of asiaticoside isolated from *Centella asiatica*" which was published in Journal of Ethnopharmacology (316 citations) followed by a review article, "Pharmacological review on *Centella asiatica*: A potential herbal cure-all" which appeared in Indian Journal of Pharmaceutical Sciences (272 citations) as in Table 2.

Co-occurrence network of authors' keywords

Fig. 2a shows the co-occurrence network of authors' keywords. "*Centella asiatica*" appeared 658 times and was the most frequent keyword used by authors. This was followed by "asiaticoside" (114 times), "antioxidant" (58 times), "madecossoside" (49 times) and "asiatic acid" (49 times). . The author keywords were further analysed using techniques described by Cobo *et al*. (32) and Feng *et al*. (33) to identify core, mature, emerging and declining topics related to *C. asiatica* research (Fig. 2b).

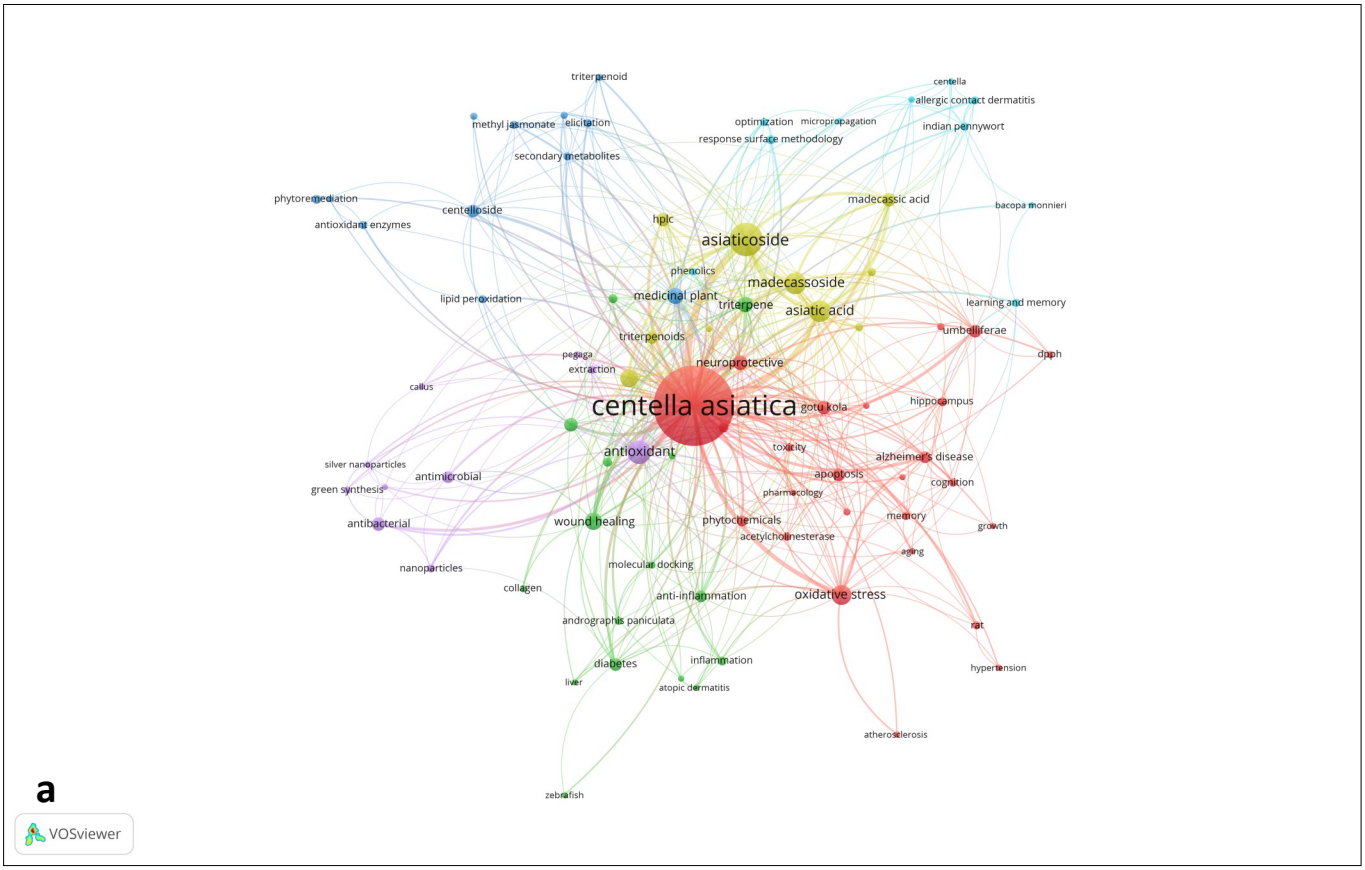
Research Collaboration

Fig. 3 shows the co-authorship network of countries co-publishing on *C. asiatica*. The size of nodes in the network map is proportionate to each country's total number of co-publications. India has the largest node followed by Malaysia, Thailand, Indonesia and China. These countries were grouped in three different clusters (green, purple and yellow clusters). Table 3 summarises the number of documents produced by each country, the number of citations these documents have acquired, and the total link strength (TLS), which is the sum of all links generated by each

Table 2. Most cited articles

Title	Year	Source	TC	Reference
Chemical, pharmacological and clinical profile of the East Asian medical plant *Centella asiatica*	2000	Phytomedicine	333	23
In vitro and *in vivo* wound healing activity of asiaticoside isolated from *Centella asiatica*	1999	Journal of Ethnopharmacology	316	24
Pharmacological review on *Centella asiatica*: A potential herbal cure-all	2010	Indian Journal of Pharmaceutical Sciences	272	25
Antioxidative activity and total phenolic compounds of leaf, root and petiole of four accessions of *Centella asiatica* (L.) Urban	2003	Food Chemistry	258	26
Pentacyclic triterpenoids from the medicinal herb, *Centella asiatica* (L.) Urban	2009	Molecules	238	27
Total phenolics and antioxidant activities of fenugreek, green tea, black tea, grape seed, ginger, rosemary, gotu kola, and ginkgo extracts, vitamin E, and tert-butylhydroquinone	2004	Journal of Agricultural and Food Chemistry	236	28
Effect of different extracts of *Centella asiatica* on cognition and markers of oxidative stress in rats	2002	Journal of Ethnopharmacology	197	29
Effect of *Centella asiatica* on pentylenetetrazole-induced kindling, cognition and oxidative stress in rats	2003	Pharmacology Biochemistry and Behavior	189	30
Cytotoxic and anti-tumour properties of certain taxa of Umbelliferae with special reference to *Centella asiatica* (L.) Urban	1995	Journal of Ethnopharmacology	174	31
Effects of *Centella asiatica* extract on dermal wound healing in rats	1996	Indian Journal of Experimental Biology	168	9

TC = total citations



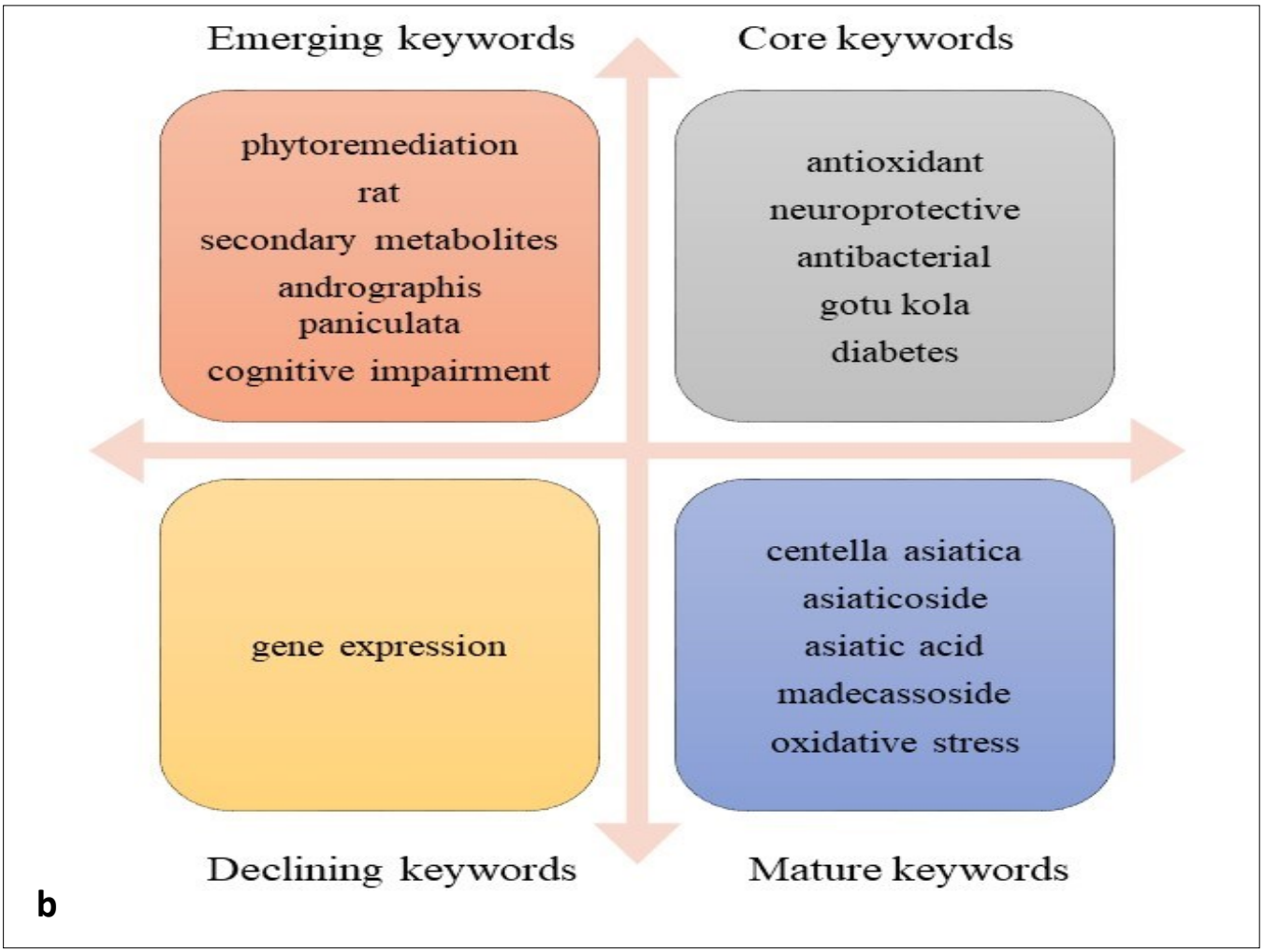


Fig. 2. (a) Co-occurrence network of authors' keywords. A minimum of 5 co-occurrences was set, resulting in 83 keywords that reach the threshold out of 2487 total keywords, and **(b)** Core, mature, emerging and declining types of keywords found in the scientific articles on *C. asiatica* (34).

document (35). Japan (0.64), the United States (0.23), Thailand (0.16), South Korea (0.15), and France (0.11)

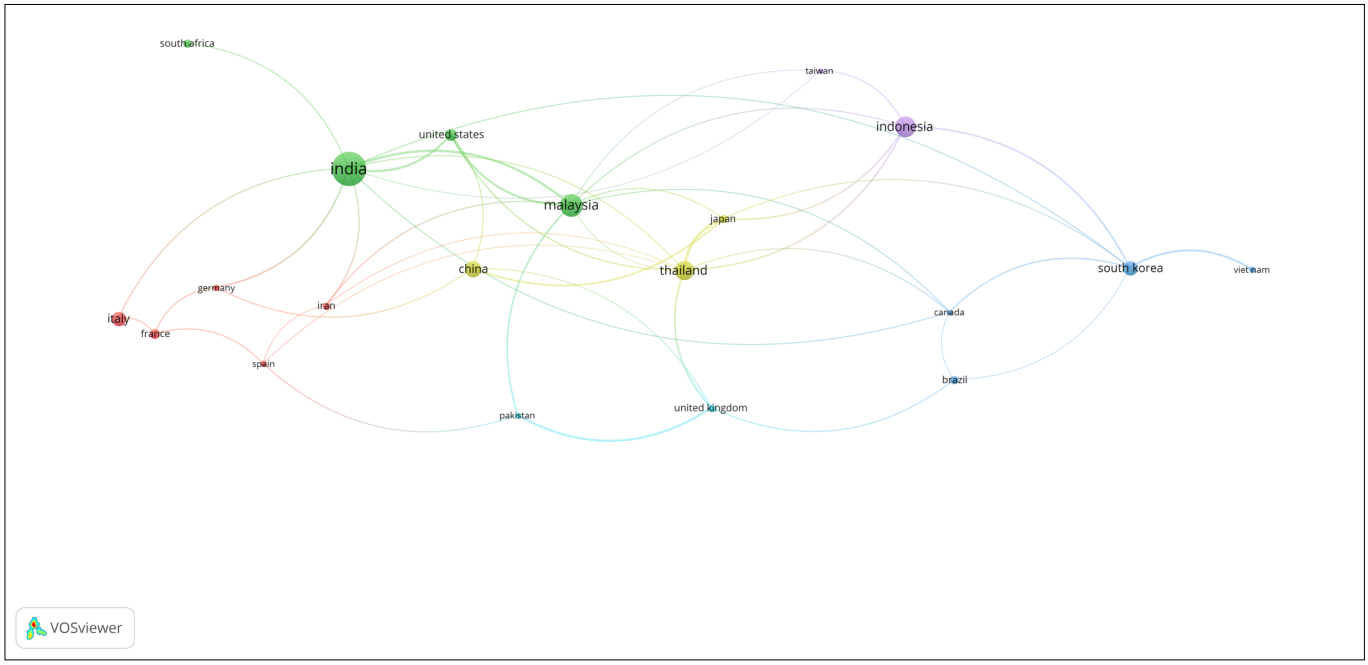


Fig. 3. Co-authorship network of countries. A minimum of 10 documents without citation restriction was set, resulting in 20 countries reaching the threshold out of 80 countries (Fractional counting).

Table 3. Top 10 countries co-publishing on *C. asiatica.*

Country	Documents	Citations	Total link strength	International collaboration*
India	339	7297	17	0.05
Malaysia	144	2702	15	0.10
Indonesia	121	407	8	0.07
Thailand	107	1677	17	0.16
China	80	1490	6	0.08
South Korea	59	1111	9	0.15
Italy	58	915	2	0.03
United States	43	1813	10	0.23
France	27	621	3	0.11
Japan	22	722	14	0.64

*A higher total link strength/number of documents indicates more international research collaboration in a given country (35).

had high TLS in proportion to the number of documents, implying international collaboration. TLS were low in proportion to the number of documents in countries like India (0.05), Malaysia (0.10), Indonesia (0.07) and China (0.08), indicating a smaller weight of international collaboration.

Fig. 4 shows the co-authorship network of authors. Authors were grouped into 21 clusters. Most of the clusters are isolated clusters and the bigger of these isolated clusters are the red and green clusters. The red cluster included 14 authors, three of whom (Belcaro G, Cesarone MR, and De Sanctis MT) were listed as the most productive authors. All of them were from the University of Studies G. d'Annunzio Chieti, Italy. While, the green cluster included nine authors, four of whom (Gray NE, Quinn JF, Soumyanath A and Caruso M) were also listed as the most productive authors. They were all from the same institution, Oregon Health & Science University in the United States.

Discussion

The first traceable paper, "*Hydrocotyle asiatica*" was a note that appeared in Lancet in 1857. However, there was no author name and abstract available. The number of documents on *C. asiatica* increased over time mainly in areas of pharmacology, toxicology and pharmaceutics, medicine, biochemistry, genetics and molecular biology, agricultural and biological sciences as well as in chemistry. The majority of the most productive authors were from the Oregon Health & Science University in the United States followed by the University of Studies G. d'Annunzio Chieti, Italy. These could be due to the co-authors from the same institution.

The most cited papers are thought to be of scientific merit, high performance, and useful for benchmarking research performance in a specific area, with a high number of citations per article (36). "Chemical, pharmacological and clinical profile of the East Asian medical plant *Centella asiatica*" was the most cited paper which ap-

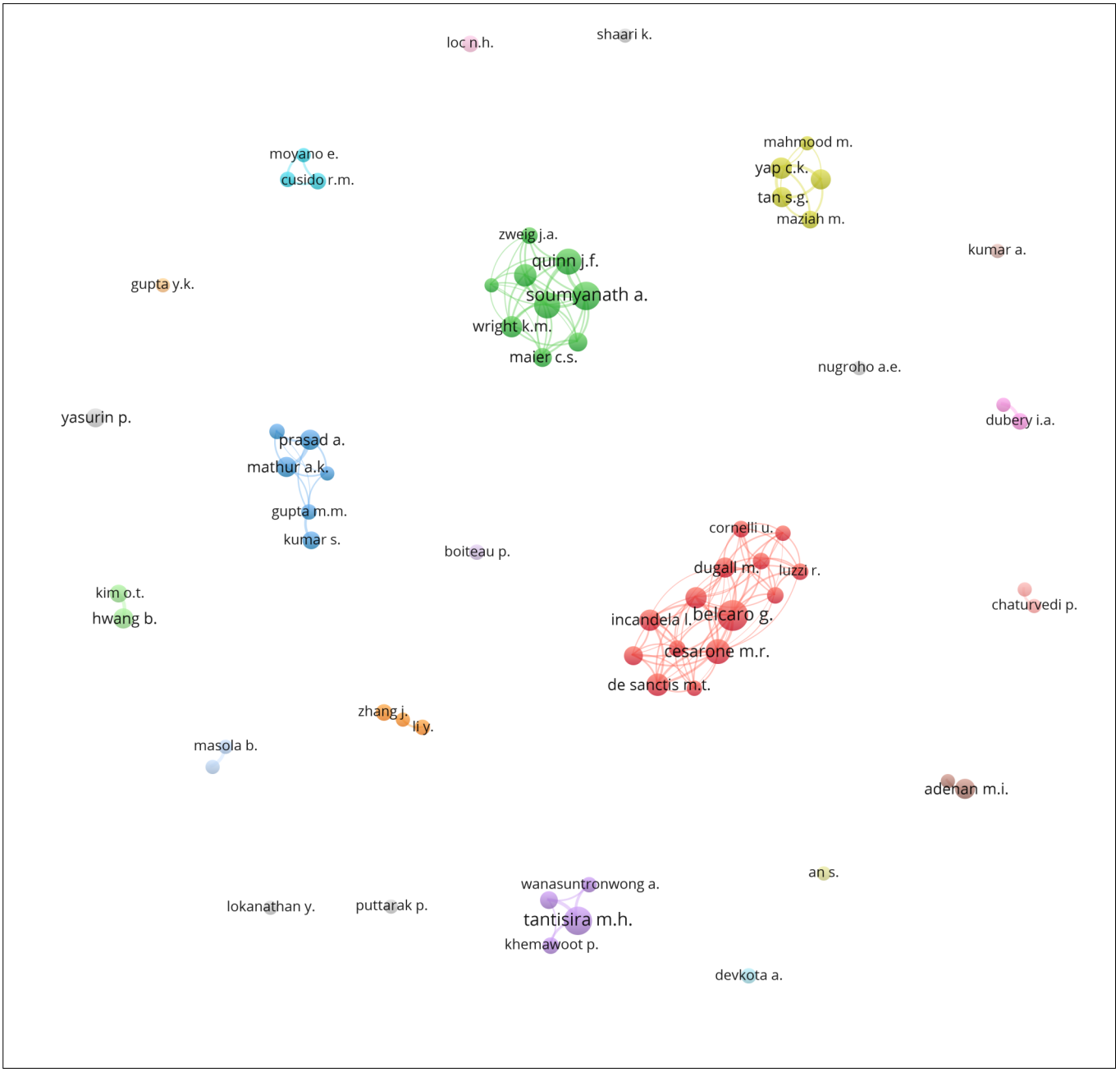


Fig. 4. Co-authorship network of authors. A minimum of 5 documents and 30 citations were set, resulting in 65 authors reaching the threshold out of 3839 authors (Fractional counting). The size of the node represents the number of documents and the same colour nodes are grouped in clusters by their high proximity or relationship.

peared in Phytomedicine. This review article received 333 citations and discussed *C. asiatica's* therapeutic potential in terms of its effectiveness and versatility (23). The second most cited article was "*In vitro* and *in vivo* wound healing activity of asiaticoside isolated from *Centella asiatica*". This original article was published in the Journal of Ethnopharmacology and received 316 citations. The study reported that *C. asiatica*'s main active constituent, asiaticoside, has substantial wound healing efficacy in both normal and delayed wound healing models (24). The third most cited paper was a review article entitled "Pharmacological review on *Centella asiatica*: A potential herbal cure-all**"** and was published in Indian Journal of Pharmaceutical Sciences. The article covers the herb's pharmacology, mechanisms of action, preclinical and clinical trials, safety precautions, research possibilities as well as the potential of drug and herb interactions for optimal and safe use (25).

The most frequent authors' keywords that appeared in the literature were "Centella asiatica", "asiaticoside", "antioxidant", "madecossoside" and "asiatic acid". The core keywords identified were "antioxidant", "neuroprotective", "antibacterial", "gotu kola" and "diabetes" suggesting the current relevant topics of *C. asiatica* research. A few recent publications highlighted the medicinal potential of *C. asiatica* including its potential use for the treatment of diabetes mellitus (37, 38) while the emerging keywords related to *C. asiatica* research were "phytoremediation", "rat", "secondary metabolites", "andrographis paniculata" and "cognitive impairment".

C. asiatica has been found to have a phytoremediation potential, an alternate method for minimising water pollution that can be used to treat industrial effluent (39, 40). The different secondary metabolites generated from

C. asiatica were reviewed by Kunjumon *et al.* (41) and have potential to be used in future chemistry, biosynthesis, chemical transformation and biological activity research. There are other novel components of *C. asiatica*, such as araliadiol, which was recently found to have neuroprotective effects that may prevent cognitive dysfunction (42). Even though this study identified several major metabolites such as "asiaticoside," "asiatic acid," and "madecossoside" as mature keywords. In a recent investigation, phytocompounds from *C. asiatica* (43) and *Andrographis paniculata* were also investigated (44). The *in silico* technique used by the authors revealed that both substances have the ability to prevent renal (43) and breast (44) cancers, and interact with the progesterone receptor to the fullest.

The co-authorship analysis is a popular method for evaluating scientific collaboration trends (45). Nodes in co-authorship networks reflect authors, organizations or countries that are linked when they co-author an article. India had the largest node in the co-authorship network of countries, with the most co-publications, followed by Malaysia, Indonesia, Thailand, and China. However, based on their TLS and the number of documents, except for Thailand, these countries had low international collaboration. Countries such as Japan and the United States, on the other hand, have shown strong international collaboration. The authors' clusters were isolated in the co-authorship network of authors, implying that the prolific authors conducted studies locally in the same institution or country, with limited collaboration with other countries (international collaboration).

Conclusion

This study showed that research on *C. asiatica* is becoming more popular, particularly in the domains of Pharmacology, toxicology, and pharmaceutics, Medicine, Biochemistry, genetics, and molecular biology, Agriculture and biological sciences, and Chemistry. Emerging areas of *C. asiatica* research include "phytoremediation," "secondary metabolites," "andrographis paniculata," and "cognitive impairment," which could be investigated in the future.

Authors contributions

All authors collaborated in the writing and editing of the manuscript.

Compliance with ethical standards

Conflict of interest: The authors declare no conflict of interest.

Ethical issues: None.

References

1. Engels, Gayle, Brinckmann Josef. Herb Profile: Gotu kola *Centella asiatica*. Family: Apiaceae. HerbalGram, The Journal of the American Botanical Council, May-July 2011; 90:1–5.
2. Ravi CS, Umesha K, HimaBindu K, Raviraja Shetty G, Anil Kumar GS. Collection and morphological variability in ecotype of Indian pennywort (*Centella asiatica* L.) of hill zone of Karnataka, India. Int J Curr Microbiol Appl Sci. 2019; 8:994–1008. https://doi:10.20546/ijcmas.2019.8 09.117
3. Peiris KHS, Kays SJ. Asiatic pennywort [*Centella asiatica* (L.) Urb.]: a little-known vegetable crop. HortTechnology 1996; 6:13–18. https://doi:10.21273/HORTTECH.6.1.13
4. Tolkah NM. Genetic variation of *Centella asiatica* based on randomly amplified polymorphic DNA. Ethnobotany J. 1999; 22:7-13.
5. Prasad A, Mathur AK, Mathur A. Advances and emerging research trends for modulation of centelloside biosynthesis in *Centella asiatica* (L.) Urban-A review. Ind Crops Prod. 2019;141:111768. https://doi.org/10.1016/j.indcrop.2019.111768
6. Huda-Faujan N, Noriham A, Norrakiah AS, Babji AS. Antioxidant activities of water extracts of some Malaysian herbs. ASEAN Food J. 2007;14 (1):61-8.
7. Sun B, Wu L, Wu Y, Zhang C, Qin L, Hayashi M, *et al*. Therapeutic potential of *Centella asiatica* and its triterpenes: a review. Front Pharmacol. 2020;11:568032. https://doi.org/10.3389/fphar.2020.568032
8. Ved DK, Goraya GS. Demand and supply of medicinal plants in India: National Medicinal Plant Board. New Delhi and Foundation for Revitalisation of Local Health Traditions, Bangalore, 2007.
9. Suguna L, Sivakumar P, Chandrakasan G. Effects of *Centella asiatica* extract on dermal wound healing in rats. Indian J Exp Biol. 1996; 34(12):1208-11.
10. Zaidan MR, Noor Rain A, Badrul AR, Adlin A, Norazah A, Zakiah I. *In vitro* screening of five local medicinal plants for antibacterial activity using disc diffusion method. Trop Biomed. 2005; 22 (2):165-70.
11. Sriepindonnta PM, Fitriani FN, Thirza SQ, Pratiwi MD, Noviardi DEPP, Kalsum U, *et al*. The potential effects of *Centella asiatica* ethanolic extracts as an anti-inflammatory agent through decreasing TNF-α expression in indomethacin-induced gastric ulcer model rats. AIP Conference Proceedings 2021;2353:030054-1–030054-8. https://doi.org/10.1063/5.0053018
12. Bajpai M, Pande A, Tewari SK, Prakash D. Phenolic contents and antioxidant activity of some food and medicinal plants. Int J Food Sci Nutr. 2005; 56(4):287-91. https://doi.org/10.1080/09637480500146606
13. Bunpo P, Kataoka K, Arimochi H, Nakayama H, Kuwahara T, Bando Y, *et al*. Inhibitory effects of *Centella asiatica* on azoxymethane-induced aberrant crypt focus formation and carcinogenesis in the intestines of F344 rats. Food Chem Toxicol. 2004; 42(12):1987-97. https://doi.org/10.1016/j.fct.2004.06.022
14. Venu Gopal Rao ML, Mastan SA. Antidiabetic effects of methanolic extract of *Centella asiatica* (Linn.) on induced hyperglycemic rats. Biosci Biotechnol Res Asia. 2007; 4(2):721–4.
15. Senthilkumar N, Varma P, Gurusubramanian G. Larvicidal and adulticidal activities of some medicinal plants against the malarial vector, *Anopheles stephensi* (Liston). Parasitol Res. 2009;104(2):237-44. https://doi.org/10.1007/s00436-008-1180-4
16. Wang XS, Dong Q, Zuo JP, Fang JN. Structure and potential immunological activity of a pectin from *Centella asiatica* (L.) Urban. Carbohydr Res. 2003; 338(22):2393-402. https://doi.org/10.1016/s0008-6215(03)00380-x
17. Pingale SS. Evaluation of effect of *Centella asiatica* on CCL4 induced rat liver damage. Pharmacologyonline. 2008; 3:537-43.
18. Gnanapragasam A, Ebenezar KK, Sathish V, Govindaraju P, Devaki T. Protective effect of *Centella asiatica* on antioxidant

tissue defense system against adriamycin induced cardiomyopathy in rats. Life Sci. 2004; 76(5):585-97. https://doi.org/10.1016/j.lfs.2004.09.009

19. Khotimah H, Wari FE, Noviasari D, Octaviana A, Supriadi RF, Norisa N, *et al*. *Centella asiatica* alleviates neurotoxicity and development of lead-exposed zebrafish larvae. AACL Bioflux. 2020;13(4):1886-98.
20. Puttarak P, Dilokthornsakul P, Saokaew S, Dhippayom T, Kongkaew C, Sruamsiri R, *et al*. Effects of *Centella asiatica* (L.) Urb. on cognitive function and mood related outcomes: a systematic review and meta-analysis. Sci Rep. 2017; 7(1):10646. https://doi.org/10.1038/s41598-017-09823-9
21. Kongkaew C, Meesomperm P, Scholfield CN, Chaiwiang N, Waranuch N. Efficacy and Safety of *Centella Asiatica* (L.) Urb. on wrinkles: a systematic review of published data and network meta-analysis. J Cosmet Sci. 2020;71(6):439-54.
22. Yusof NNM, Tg Abdul Rahman TAF, Abd Aziz NA, Hadizam BB, Suleiman Isleih ARI. Systematic literature review on *Centella asiatica*. Sains Insani. 2020;5(1):135-41.
23. Brinkhaus B, Lindner M, Schuppan D, Hahn EG. Chemical, pharmacological and clinical profile of the East Asian medical plant *Centella aslatica*. Phytomedicine. 2000;7(5):427- 48. https://doi.org/10.1016/s0944-7113(00)80065-3
24. Shukla A, Rasik AM, Jain GK, Shankar R, Kulshrestha DK, Dhawan BN. *In vitro* and *in vivo* wound healing activity of asiaticoside isolated from *Centella asiatica*. J Ethnopharmacol. 1999; 65(1):1-11. https://doi.org/10.1016/s0378-8741(98)00141-x
25. Gohil KJ, Patel JA, Gajjar AK. Pharmacological review on *Centella asiatica*: a potential herbal cure-all. Indian J Pharm Sci. 2010;72(5):546-56. https://doi.org/10.4103/0250-474X.78519
26. Zainol MK, Abd-Hamid A, Yusof S, Muse R. Antioxidative activity and total phenolic compounds of leaf, root and petiole of four accessions of *Centella asiatica* (L.) Urban. Food Chem. 2003;81 (4):575-81. https://doi.org/10.1016/S0308-8146(02)00498-3
27. James JT, Dubery IA. Pentacyclic triterpenoids from the medicinal herb, *Centella asiatica* (L.) Urban. Molecules. 2009;14 (10):3922-41. https://doi.org/10.3390/molecules14103922
28. Rababah TM, Hettiarachchy NS, Horax R. Total phenolics and antioxidant activities of fenugreek, green tea, black tea, grape seed, ginger, rosemary, gotu kola, and ginkgo extracts, vitamin E, and tert-butylhydroquinone. J Agric Food Chem. 2004;*52* (16):5183–6. https://doi.org/10.1021/jf049645z
29. Veerendra Kumar MH, Gupta YK. Effect of different extracts of *Centella asiatica* on cognition and markers of oxidative stress in rats. J Ethnopharmacol. 2002;79(2):253-60. https://doi.org/10.1016/s0378-8741(01)00394-4
30. Gupta YK, Veerendra Kumar MH, Srivastava AK. Effect of *Centella asiatica* on pentylenetetrazole-induced kindling, cognition and oxidative stress in rats. Pharmacol Biochem Behav. 2003;74 (3):579-85. https://doi.org/10.1016/s0091-3057(02)01044-4
31. Babu TD, Kuttan G, Padikkala J. Cytotoxic and anti-tumour properties of certain taxa of Umbelliferae with special reference to *Centella asiatica* (L.) Urban. J Ethnopharmacol. 1995;48(1):53 -7. https://doi.org/10.1016/0378-8741(95)01284-k
32. Cobo MJ, Lopez-Herrera AG, Herrera-Viedma E, Herrera F. An approach for detecting, quantifying, and visualizing the evolution of ´ a research field: A practical application to the Fuzzy Sets Theory field. J Informetri. 2011;5(1):146-66. https://doi.org/10.1016/j.joi.2010.10.002
33. Feng J, Mu X, Wang W, Xu Y. A topic analysis method based on a three-dimensional strategic diagram. J Inf Sci. 2020;47(6):770-82. https://doi.org/10.1177/0165551520930907
34. Castaneda DI, Manrique LF, Cuellar S. Is organizational learning being absorbed by knowledge management? A systematic review. J Knowl Manag. 2018;22(2):299-325. https://doi.org/10.1108/JKM-01-2017-0041
35. Belli S, Mugnaini R, Balta J, Abadal E. Coronavirus mapping in scientific publications: When science advances rapidly and collectively, is access to this knowledge open to society? Scientometrics. 2020;124:2661-85. https://doi.org/10.1007/s11192-020-03590-7
36. León-Vargas F, Arango Oviedo JA, Luna Wandurraga HJ. Two decades of research in artificial pancreas: insights from a bibliometric analysis. J Diabetes Sci Technol. 2021;16(2):434–45. https://doi.org/10.1177/19322968211005500
37. Legiawati L, Bramono K, Indriatmi W, Yunir E, Setiati S, Jusman S, et al. Oral and topical *Centella asiatica* in type 2 Diabetes Mellitus patients with dry skin: A three-arm prospective randomized double-blind controlled trial. Evid-Based Compl Alternat Med. 2020;2020:7253560. https://doi.org/10.1155/2020/7253560
38. Oyenihi AB, Ahiante BO, Oyenihi OR, Masola B. Chapter 21 – *Centella asiatica*: its potential for the treatment of diabetes. *In*: Preedy VR, Ed. Diabetes. Academic Press, 2020: 213-22.
39. Li Y, Liu K, Wang Y, Zhou Z, Chen C, Ye P, et al. Improvement of cadmium phytoremediation by *Centella asiatica* L. after soil inoculation with cadmium-resistant *Enterobacter sp*. FM-1. Chemosphere. 2018;202:280–88. https://doi.org/10.1016/j.chemosphere.2018.03.097
40. Hanafiah MM, Zainuddin MF, Mohd Nizam NU, Halim AA, Rasool A. Phytoremediation of aluminum and iron from industrial wastewater using *Ipomoea aquatic* and *Centella asiatica*. Appl Sci. 2020;10(9):3064. https://doi.org/10.3390/app10093064
41. Kunjumon R, Johnson AJ, Baby S. *Centella asiatica*: Secondary metabolites, biological activities and biomass sources. Phytomedicine Plus. 2022;2(1):100176. https://doi.org/10.1016/j.phyplu.2021.100176
42. Fujimori H, Ohba T, Mikami M, et al. The protective effect of *Centella asiatica* and its constituent, araliadiol on neuronal cell damage and cognitive impairment. J Pharmacol Sci. 2022;148 (1):162–71. https://doi.org/10.1016/j.jphs.2021.11.001
43. Zulkipli NN, Zakaria R, Long I, Abdullah SF, Muhammad EF, Wahab HA, *et al*. *In Silico* analyses and cytotoxicity study of asiaticoside and asiatic acid from Malaysian plant as potential mTOR inhibitors. Molecules. 2020;25(17):3991. https://doi.org/10.3390/molecules25173991
44. Swargiary G, Mani S. ER and PGR targeting ability of phytocompounds derived from *Centella asiatica* and *Andrographis paniculata*: An *in-silico* approach. J Herb Med. 2022; 32:100541. https://doi.org/10.1016/j.hermed.2022.100541
45. Fonseca BdeP, Sampaio RB, Fonseca MVd, Zicker F. Coauthorship network analysis in health research: method and potential use. Health Res Policy Sys. 2016;14(1):34. https://doi.org/10.1186/s12961-016-0104-5