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A Bibliometric Study of Traditional Medicinal Plant Database Research, 2001– 2021

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Abstract

The main objective of this study is to conduct a bibliometric study of Traditional Medicinal Plant Database research analysis of twenty years (2001 – 2021) of trends in Traditional Medicinal Plant Database research topics. The literature was extracted and analyzed using the Web of Science database. VOSViewer software was used to identify and visualize key trends, influential authors, and journals. The 654 filtered documents were selected based on three main criteria which are (i) Topics on Traditional Medicinal Plant Database, (ii) Type of documents on 'Article', and (iii) Year Published within 2001 to 2021. We conducted several types of analyses on the body of research using VOSViewer which are (i) Co-authorship analysis, (ii) Co-occurrence analysis, (iii) Citation analysis, and (iv) Co-citation analysis. The main contribution and motivation for this study are in the form of a conceptual framework of Traditional Medicinal Plant Database research topics in guiding future research in supporting the UN Sustainable Development Goals agenda on 'Quality Education' and 'Good Health and Well-being'. There are five major keyword theme clusters concerning the Traditional Medicinal Plant Database that we had determined based on the clusters which are (i) Plant Identification, (ii) Bioactive Activities, (iii) Medicinal Properties, (iv) Plant Classification, and (v) Plant Species themes.

Keywords: Traditional Medicinal Plant Database, Sustainable Development Goals, Information Technology

Introduction

There are ongoing trends Traditional Medicinal Plant Database research topics (Ningthoujam et al., 2012) (Kumar et al., 2018) in guiding future research in supporting the UN Sustainable Development Goals agenda on 'Quality Education' and 'Good Health and Well-being'. Because academic literature on Traditional Medicinal Plant Database research topics is dispersed across domains, a full literature mapping is required. Specifically, we seek answers to the following questions:

- Over the last two decades (2001-2021), how has the amount of study been on the Traditional Medicinal Plant Database?

- What are the key terms associated with the Traditional Medicinal Plant Database in the literature (2001-2021)?
- Who are the most prolific researchers and what links do they have to each other in Traditional Medicinal Plant Database literature (2001-2021)?
- Which journals and countries are the most prominent and influential in their publication of Traditional Medicinal Plant Database literature (2001-2021)?
- What is the conceptual framework of Traditional Medicinal Plant Database research topics in guiding future research?

Methods

The main objective of this study is to conduct a bibliometric study of Traditional Medicinal Plant Database research analysis of twenty years (2001 – 2021) of trends in Traditional Medicinal Plant Database research topics. A similar method on scientometric analysis of twenty years trends on various topics was previously conducted by researchers (Isa & Amin, 2022) (Isa et al., 2022). Using the method of extraction of information from the Web of Science database and VOSViewer software (Van Eck and Waltman, 2010) techniques, analysis, and reporting (Park et al., 2020), papers published on Traditional Medicinal Plant Database research topics were extracted and analyzed to identify and visualize main trends, authors (influential), and related journals. The 654 filtered documents were selected based on three main criteria which are (i) Topics on Traditional Medicinal Plant Database, (ii) Type of documents on 'Article', and (iii) Year Published within 2001 to 2021. We conducted several types of analyses on the body of research using VOSViewer which are (i) Co-authorship analysis, (ii) Co-occurrence analysis, (iii) Citation analysis, and (iv) Co-citation analysis. The results are presented in the next section.

Results and Discussions

Fig. 1 shows the number of documents features' search terms – Traditional Medicinal Plant Database (2001-2021). The following discusses the results and discussion for (i) 'Co-authorship analysis', (ii) 'Co-occurrence analysis', (iii) 'Citation analysis', and (iv) 'Co-citation analysis'. A conceptual framework was also being developed.

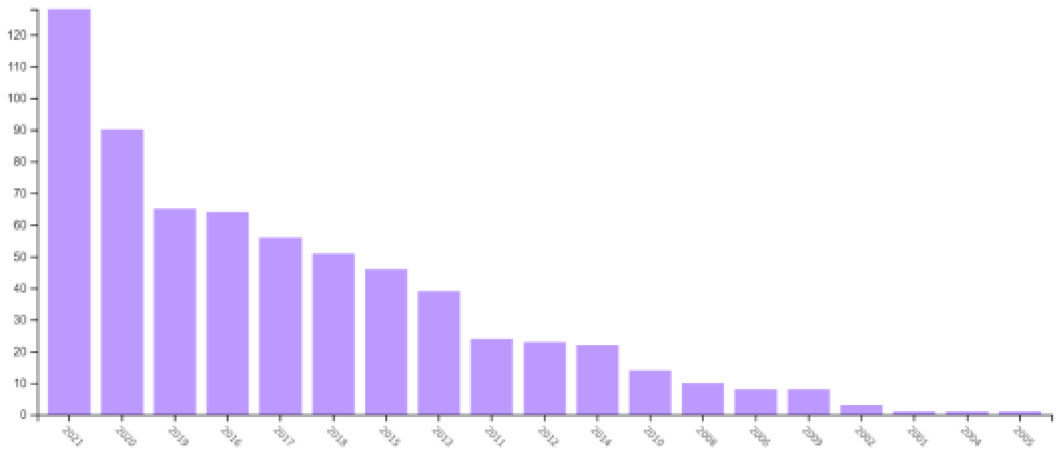

Fig. 1. Number of documents feature search terms – Traditional Medicinal Plant Database (2001-2021)

Co-authorship Analysis

In general, 'co-authorship analysis can be described as the greater the number of co-authored papers, the higher the relatedness of authors, institutions, and countries' (Van Eck and Waltman, 2010) (Park et al., 2020). In total, 3938 authors were involved in writing the 654 articles that comprised the Web of Science results related to the Traditional Medicinal Plant Database from the year 2001 to 2021. By using VOSviewer, the minimum number of documents published by an author was set to one and the minimum number of citations of an author to 150. 92 authors who met this threshold. Subsequently, the result of co-authorship analysis is shown in Fig. 2 which includes one prominent cluster (16 authors). The cluster (red node) comprise of 16 authors (The names of the authors are Barikmo, Ingrid; Berhe, Nega; Blomhoff, Rune; Bohn, Siv K.; Carlsen, Monica H., Dragland, Steinar; Halvorsen, Bente I., Holte, Kari; Jacobs, Daviord r., jr.; Phillips, Katherine M.; Sampson, Laura; Sanada, Chiko; Senoo, Haruki; Umezono, Yuko; Willett, Walter C., Wiley, Carol).

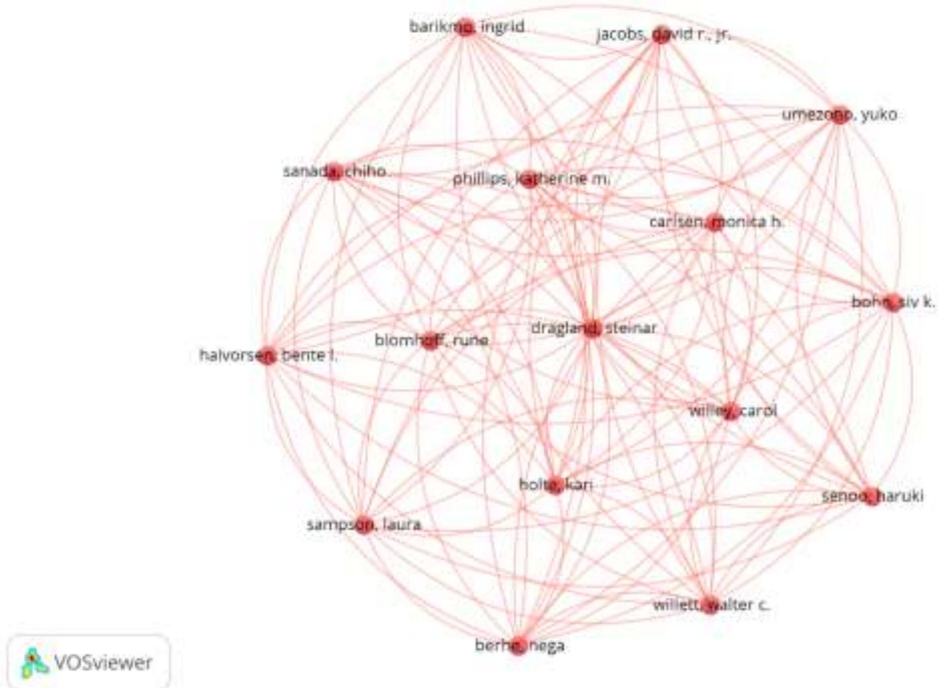

Fig. 2. Co-authorship diagram (Generated by VOSviewer)

The top six countries in terms of the number of papers published are listed in Table 1. Scholars from the China and USA have the most papers and have the most citations (by country).

Table 1
The top ten countries in terms of the number of papers published

Country	Documents	Citations
China	265	3866
USA	69	1908
India	64	742
Iran	41	692
Spain	31	661
Germany	30	987
Australia	29	1175
England	27	899
South Africa	24	389
South Korea	22	297

By using VOSviewer, the threshold for analysis was set for one document published per country with 50 citations. As a result, 44 of the 91 countries in our data met this criterion. China is the largest node because it has the most papers published. These clusters, when analyzed further, comprise seven networks (clusters) of countries that work together, as shown in Fig. 3. The first cluster (in red node) comprises Australia, France, Greece, Hungary, Iran, Morocco, Netherlands, Norway, Romania, Spain, and Sweden. The second cluster (green node) comprises Canada, England, Nepal, New Zealand, Scotland, Singapore, Switzerland, and Taiwan. Spain and Switzerland. The third cluster (in dark blue node) comprises Austria, Indonesia, Japan, Malaysia, Mexico, South Korea, and Thailand. The fourth cluster (yellow node) comprises Egypt, India, Mauritius, China, Saudi Arabia, South Africa, and Turkey. The fifth cluster (purple node) comprises Argentina, Brazil, Denmark, Estonia, and the USA. The sixth cluster (light blue node) comprises Angola, Cameroon, Germany, and Italy. The seventh cluster (orange node) comprises Mozambique and Portugal.

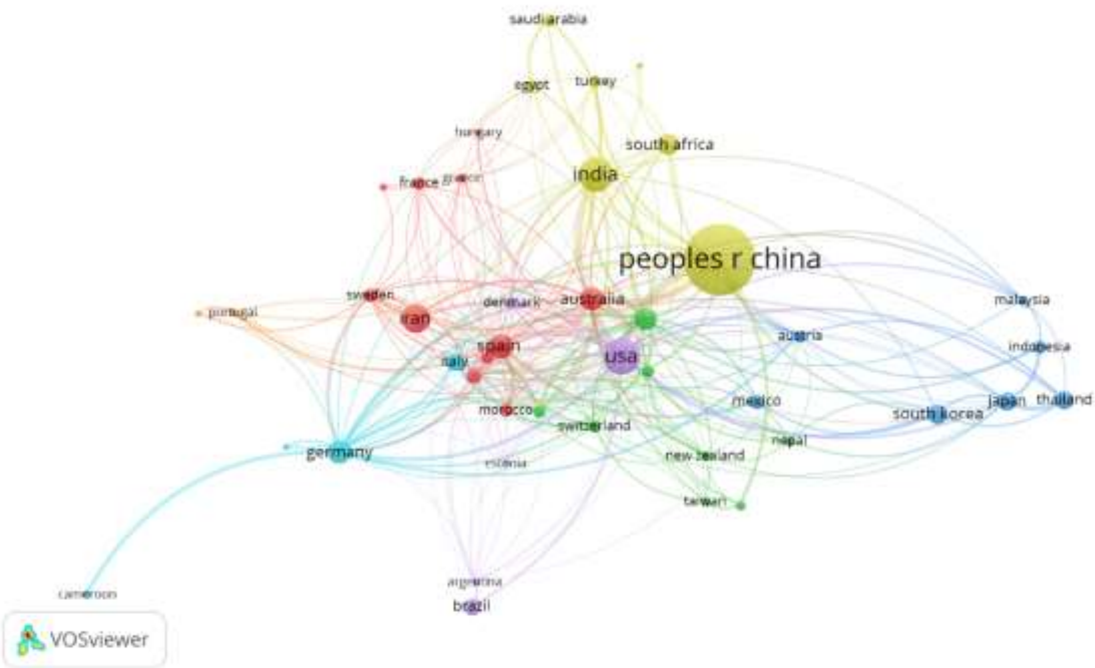

Fig. 3. Co-authoring countries are shown on the mapping (Generated by VOSviewer)

Co-occurrence Analysis

In general, 'the bigger the number of papers in which two keywords appear together, the higher the relatedness of these keywords, according to co-occurrence analysis' (Van Eck and Waltman, 2010; Park et al., 2020). VOSViewer collects 'co-occurrences of both author keywords and all other keywords, demonstrating their frequency and relatedness' (Van Eck and Waltman, 2010; Park et al., 2020). Co-occurrence analysis includes 'measuring the number of documents in which two terms or words are found together' (Van Eck and Waltman, 2010; Park et al., 2020). VOSViewer was set for a threshold of ten documents in which a keyword had to appear for it to be included. Out of 4061 keywords, the data subsequently resulted in 88 keywords with accord to the aforementioned threshold. Table 2 lists the ten most commonly occurring keywords that appeared in our sample of 654 papers. The top five most commonly occurring keywords are 'Database', 'Identification', 'Medicinal Plants, 'Expression', and 'Plants'.

There are five major keyword clusters concerning traditional medicinal plant database research (2001 – 2021), that we had determined based on the theme clusters which are (i) Plant Identification, (ii) Bioactive Activities, (iii) Medicinal Properties, (iv) Plant Classification, and (v) Plant Species themes. Fig. 4 shows the mapping of the keyword co-occurrences and also depicts the dominant links between keywords and clusters. First, the shown in red that we classify as 'Plant Identification' oriented-keywords comprises 'accumulation', 'annotation', 'arabidopsis', 'biosynthesis', 'classification', 'database', 'evolution', 'expression', 'family', 'flavonoid biosynthesis', 'gene', 'generation', 'genes', 'genome', 'identification', 'metabolism', 'metabolomics', 'molecular-cloning', 'pathway', 'rna-seq', 'sequence', 'stress', 'tool' and 'transcriptome'.

Second, the keywords that are shown in green that we classified as 'Bioactive Activities oriented-keywords comprises 'activation', 'apoptosis', 'cancer', 'cells', 'constituents', 'discovery', 'drug discovery', 'drugs', 'extracts', 'flavonoids', 'inflammation', 'inhibition', 'mechanism', 'molecular docking', 'natural-products', 'network pharmacology', 'nf-kappa-b', 'oxidative stress', 'prediction', 'protein', 'proteomics' and 'traditional chinese medicine'. Third, the terms, that are shown in blue that we classified as 'Medicinal Properties' oriented-keywords comprises 'antibacterial', 'antibacterial activity', 'antimicrobal activity', 'antioxidant', 'antioxidant activity', 'chemical-composition', essential oil', 'essential oils', 'growth', 'in-vitro', 'leaves', 'medicinal plant', 'pharmacology', 'phytochemicals', 'phytochemistry', 'plant', 'plants', 'toxicity' and 'traditional uses'. Fourth, the terms that are shown in yellow that we classifIed as 'Plant Classification' oriented-keywords are 'conservation', district', 'ethnobotanical survey', 'ethnobotany', 'ethnomedicine', 'ethnopharmacology', 'extract', 'herbal medicine', 'knowledge', 'I', 'management', 'medicinal plants', 'medicinal-plants', 'prevalence', 'traditional knowledge' and 'traditional medicine'. Fifth, the terms that are shown in purple that we classified as 'Plant Species' oriented-keywords are 'biodiversity', 'diversity', 'dna', 'dna barcoding', 'its2', 'phylogeny' and 'species identification'.

Table 2
Most Commonly Occurring Keywords

Keyword	**Number of Occurrences**
Database	76
Identification	77
Medicinal Plants	67
Expression	59
Plants	57
Medicinal-plants	54
Traditional Medicine	51
Transcriptome	43
In-vitro	34
Traditional Chinese Medicine	35

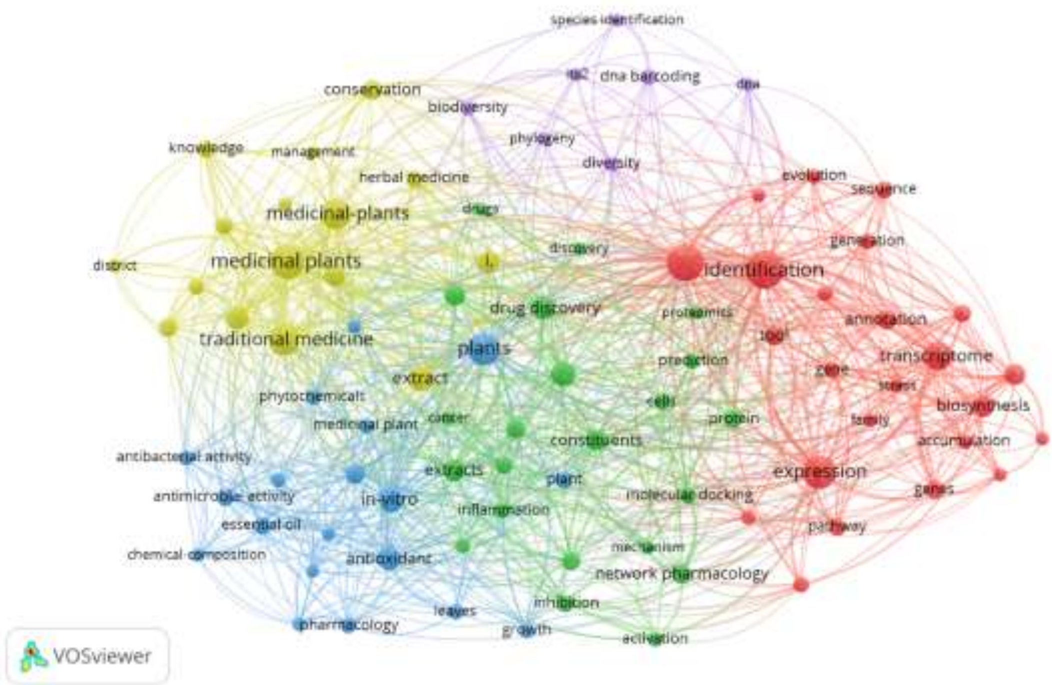

Fig. 4. Keyword co-occurrences are shown on the mapping (Created by VOSviewer)

Citation Analysis

In general, 'the more the number of times authors, journals, and publications cite each other, the more connected these items are, according to citation analysis' (Van Eck and Waltman, 2010; Park et al., 2020). Citation analysis is 'based on the relatedness of entities like authors and journals, which is determined by how many times they cite each other'(Van Eck and Waltman, 2010; Park et al., 2020). Which documents in the field of Traditional Medicinal Plant Database research cite each other? We use VOSviewer and set the threshold that a paper is cited at least thirty times. Out of 654 documents, only 91 documents met this threshold which created nine clusters as shown in **Fig. 5**.

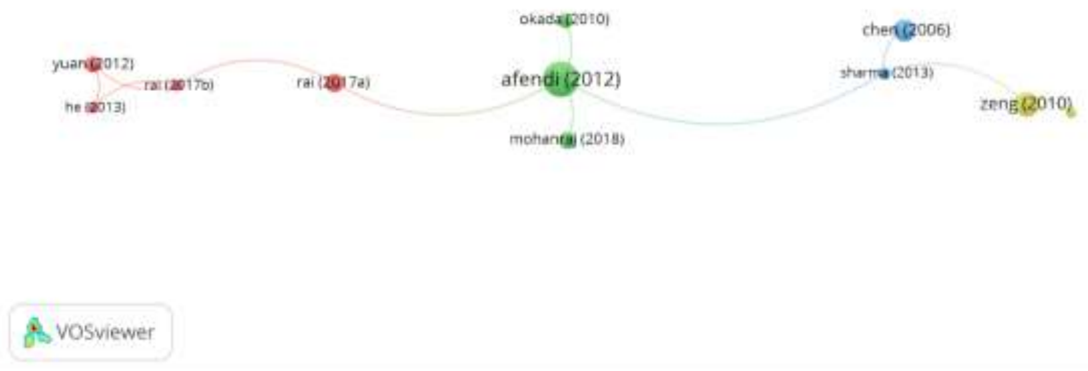

Fig. 5. Citations by paper are shown on the mapping (Created by VOSviewer)

The threshold was set in VOSviewer that a journal had to be cited at least five times to be included in the map and the minimum number of a document of a source is three. 18 journals out of 307 sources met this criterion and of these and created four main clusters as shown in **Fig. 6**. First, the cluster comprises of ‘Biotechnology & Biotechnological Equipment’, ‘BMC Genomics’, ‘BMC Plant Biology’, ‘Frontiers in Plan Science’, ‘International Journal of Molecular Sciences’, ‘PLOS One’ and ‘Scientific Reports’. Second, the cluster comprises of ‘Evidence-Based Complementary and Alternative Medicine’, ‘Journal of Ethnobiology and Ethnomedicine’, ‘Journal of Ethnopharmacology’, ‘Pharmaceutical Biology’ and ‘Plants-Basel’. Third, the cluster comprises of ‘African Journal of Traditional Complementary and Alternative Medicines’, ‘Bioinformation’, ‘Frontiers in Pharmacology’, and ’Journal of Traditional Chinese Medicine’. Fourth, the cluster comprises ‘Phytomedicine’.

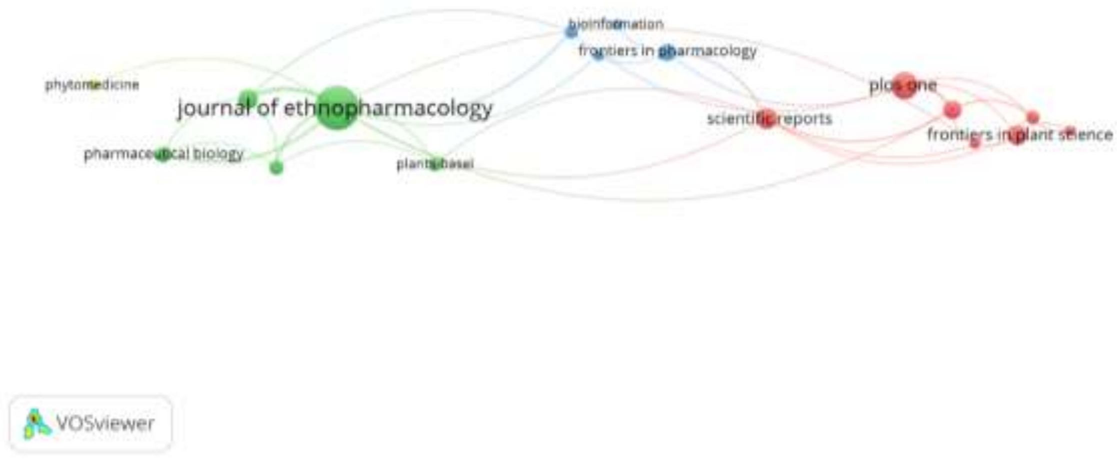

Fig. 6. Citations by the journal are shown on the mapping (Created by VOSviewer)

Co-citation Analysis

In general, ‘the greater the number of times authors, journals, and publications are referenced together, the stronger the relatedness of these items, according to the co-citation analysis’ (Van Eck and Waltman, 2010) (Park et al., 2020). Co-citation analysis looks at ‘how closely elements like authors, journals, and publications are mentioned together and how it has shaped academic discussions in the subject’ (Van Eck and Waltman, 2010) (Park et al., 2020).

The co-citation analysis was done on all authors cited in the 654 papers. A threshold of 59 citations per author was set in the VOSviewer. Thus, this subsequently filtered the data to only three authors to be analyzed for the co-citation network map analysis. The top three most-cited authors were (i) Grabherr, M. G. (64 citations), (ii) Kanehisa, M. (90 citations), and (iii) Wangchuk, P. (59 citations).

Conceptual Framework

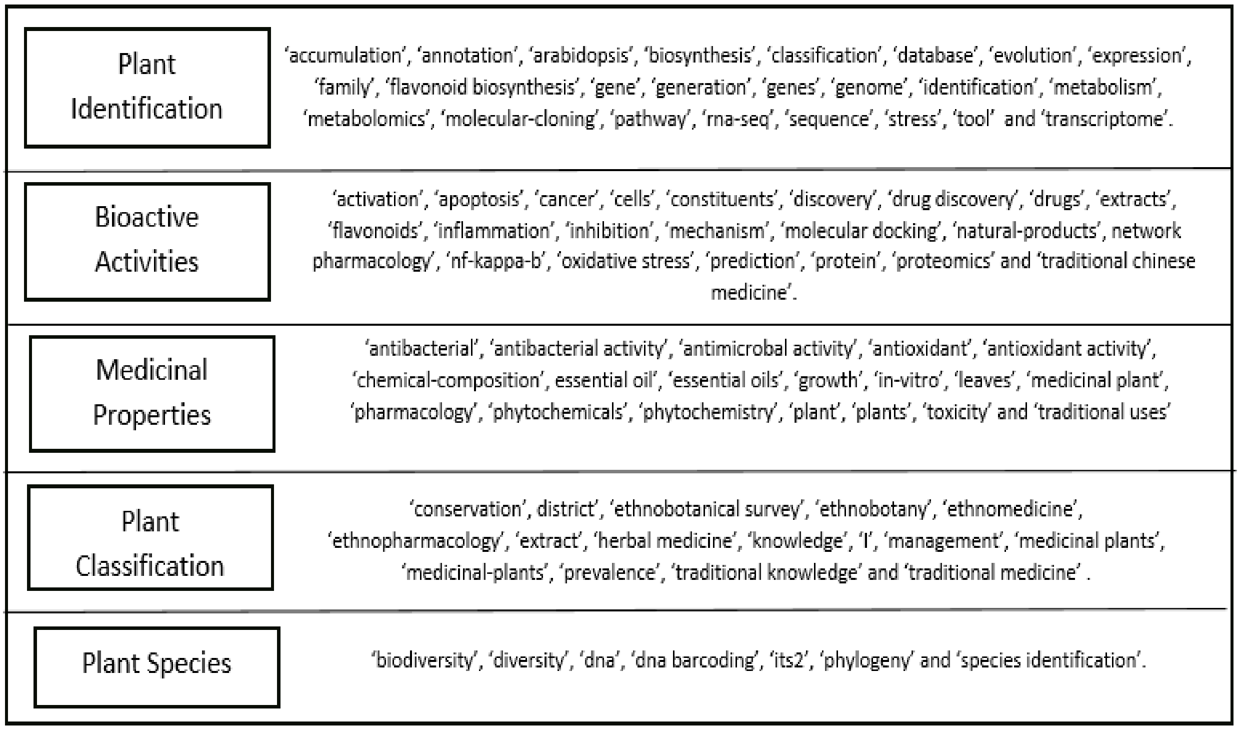

Fig. 7. A conceptual framework of Traditional Medicinal Plant Database research topics

Based on the bibliometric study of traditional medicinal plant database research (2001 – 2021), we propose a conceptual framework of Traditional Medicinal Plant Database research topics (see Fig. 7) to guide future research. There are five major keyword clusters concerning traditional medicinal plant database research (2001 – 2021), that we had determined based on the clusters which are (i) Plant Identification, (ii) Bioactive Activities, (iii) Medicinal Properties, (iv) Plant Classification, and (v) Plant Species themes. Fig. 4 shows the mapping of the keyword co-occurrences and also depicts the dominant links between keywords and clusters. First, the theme we classify as 'Plant Identification' oriented-keywords comprises 'accumulation', 'annotation', 'arabidopsis', 'biosynthesis', 'classification', 'database', 'evolution', 'expression', 'family', 'flavonoid biosynthesis', 'gene', 'generation', 'genes', 'genome', 'identification', 'metabolism', 'metabolomics', 'molecular-cloning', 'pathway', 'rna-seq', 'sequence', 'stress', 'tool', and 'transcriptome'.

Second, the theme we classified as 'Bioactive Activities' oriented-keywords comprises 'activation', 'apoptosis', 'cancer', 'cells', 'constituents', 'discovery', 'drug discovery', 'drugs', 'extracts', 'flavonoids', 'inflammation', 'inhibition', 'mechanism', 'molecular docking', 'natural-products', 'network pharmacology', 'nf-kappa-b', 'oxidative stress', 'prediction', 'protein', 'proteomics' and 'traditional chinese medicine'. Third, the theme we classified as 'Medicinal Properties' oriented-keywords comprises 'antibacterial', 'antibacterial activity', 'antimicrobal activity', 'antioxidant', 'antioxidant activity', 'chemical-composition', essential oil', 'essential oils', 'growth', 'in-vitro', 'leaves', 'medicinal plant', 'pharmacology', 'phytochemicals', 'phytochemistry', 'plant', 'plants', 'toxicity' and 'traditional uses'. Fourth, the theme we classified as 'Plant Classification' oriented-keywords comprises 'conservation', district', 'ethnobotanical survey', 'ethnobotany', 'ethnomedicine', 'ethnopharmacology', 'extract', 'herbal medicine', 'knowledge', 'l', 'management', 'medicinal plants', 'medicinal-plants', 'prevalence', 'traditional knowledge' and 'traditional medicine'. Fifth, the theme we classified as 'Plant Species' oriented-keywords comprises 'biodiversity', 'diversity', 'dna', 'dna barcoding', 'its2', 'phylogeny' and 'species identification'. The theme and sub-themes as shown in Fig. 7 are important to be referred to for future possible research in Traditional Medicinal Plant Database research topics

Conclusion

The theme and sub-themes as shown in Fig. 7 are important to be referred to for future possible research in Traditional Medicinal Plant Database research topics. The main contribution and motivation for this study are in the form of the conceptual framework of Traditional Medicinal Plant Database research topics in supporting the UN Sustainable Development Goals agenda on 'Quality Education' and 'Good Health and Well-being'.

Acknowledgements

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