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# Revealing Interdisciplinary Trends and Collaborations in Bunga Telang Bibliometric Research Through VOS Viewer Analysis.

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## Abstract

*The purpose of this study is to analyze how the research trends of butterfly pea flowers and collaborations in various scientific fields are classified along with the trend models that occur. In addition, this study also aims to determine topics that can be used as research variables in the future. The research method used by the author is through a bibliometric approach with the initial stage of searching for keywords in the form of research "butterfly pea flower" through research from publish or perish with the choice of regional publications using Scopus as the database base within a period of 10 years from 2013 to 2023. The author conducted screening and filtering of the data and the researcher found 215 articles and obtained 207 articles related to the theme taken. After this, the authors compiled it using the VOS Viewer metadata program to visualize ongoing research trends and have research opportunities in the future. The results of this study showed and found that data analysis related to butterfly pea flowers was divided into 11 clusters with topics centered on agricultural and biological sciences with a proportion of 28% of the total interdisciplinary collaborative research. This research is limited to variations of the butterfly pea model from the research articles reviewed. It turns out that butterfly pea flowers are still rarely found in research journals, especially collaborations with the scientific field of tourism and tourism product innovation which of course includes the tourism trend of Wellness Tourism and the use of innovative butterfly pea processed products.*

***Keywords:*** *Bibliometric analysis; butterfly peas; agricultural and biological sciences; Publish or Perish; VOS Viewer.*

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## 1. Introduction

Telang flower is a natural resource that can be utilized in various fields, such as food, medicine, and cosmetics. In recent years, interest in studying Telang Flowers from the perspective of product innovation has increased [1]. Butterfly Pea belongs to the Fabaceae family. The scientific name of the Butterfly Pea Flower is Clitoria ternatea. Traditionally the butterfly pea flower is an annual herbaceous plant that is widespread in many tropical and subtropical countries, especially in South and Central America, the East and West Indies, China, and India.

Telang flower is blue and is used to give green color to rice. The leaves are used as a food coloring or as a potted vegetable. The young fruit can be eaten like green beans, but information on cultivation and production is limited. are known to contain various bioactive compounds that have the potential to be applied in food, medicine, and cosmetics. Telang flower is also known as butterfly pea. The butterfly pea flower is used in Ayurveda, and its root is the most widely used and is bitter, cooling, and laxative, In its development, the butterfly pea flower is widely cultivated by the community in the front yard of residents' houses as a collection plant [2].

In Karanganyar the butterfly pea flower has been used in traditional pottery in Karanganyar, Indonesia, and is a symbol of local wisdom in the region [3]. Even in Another study found the use of eggplant can be a growth inhibitor against Staphylococcus epidermidis bacteria (bacteria in the skin) [4]. In his research [5] The butterfly pea flower was obtained from Purwomartani Village, Kalasan District, Sleman Regency, Special Region of Yogyakarta. The IC50 value of the butterfly pea flower extract (Clitoria ternatea L) was 41.36 ± 1.191 μg/mL, belonging to the category of very potential as an antioxidant. With the emergence of renewable innovations of butterfly pea flowers which are used as tea powder. research carried out [6] found that the interaction standard between temperature and drying time would affect the water content of pea flower extract, total phenols, flavonoids, anthocyanins, and antioxidant activity. Treatment with a drying temperature of 50ºC and a length of time of 4 hours was the best treatment which produced herbal tea with antioxidant activity (based on IC50 value) of 128.25 ppm, water content 10.18%, essence content 51.60%, total phenols 515.48 mg/100g, flavonoids 23.99 mg/100g, anthocyanins 249.69 mg/100g, liked color, slightly liked aroma, less astringent and liked taste, overall acceptance liked.

The works mentioned above focus on the feasibility and content values of the butterfly pea flower in many aspects and locations globally. Researchers have not found many works related to bibliometric analysis search data related to the use of butterfly pea innovations in tourism.

Motivated by this, this paper discusses a bibliometric analysis of models of trend identification and collaboration of interdisciplinary relationships in research related to the butterfly pea flower. The novelty of this work is that, unlike other works, the author explores the Vos viewer as a tool for bibliometric analysis of the potential for innovation in Telang flowers. In summary, this work makes the following contributions:

1.1. The researcher looked for previous research data related to butterfly peas through the Scopus database in publish or perish
1.2. Researchers describe the comparison matrix
1.3. The researcher presents data on the implementation of the year of publication
1.4. The researcher describes the type of document
1.5. Researchers describe Related Types of Source
1.6. Researchers formulate and sort the best 20-article citation data
1.7. The researcher formulates and sorts data on the top five publisher rankings
1.8. Researchers formulate and sort the top five data-related topics
1.9. Researchers presented topic visualization through the use of the VOS Viewer
1.10. Researchers formulate research location data

In terms of content research and development, BuSeaweed is considered very safe and has good antioxidant activity. In this case, the development of innovation in processed butterfly pea flowers is one of the potential things that can be developed in today's society. Where the butterfly pea flower itself has grown and cared for in every yard of the house.

This is an opportunity that can be explored more by other researchers. The results of this study can provide an overview of the current condition of Telang Flower research, as well as the potential for its development in the future. By identifying research gaps and collaboration opportunities, we can encourage interdisciplinary research and innovation in the field. In addition, by mapping research landscapes and collaborative networks, researchers can facilitate the transfer and exchange of knowledge among researchers, policymakers, and other stakeholder researchers.

Overall, The concept of this research tries to develop bibliometric analysis is a quantitative method used to analyze scientific literature and related citation patterns [7] By conducting a bibliometric analysis on the butterfly pea research, the authors can identify trends and patterns of collaboration as well as interdisciplinary relationships and research dynamics related to the butterfly pea flower.

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This information can be useful for researchers, policymakers, and stakeholders who are interested in the butterfly pea flower and its potential applications as well as forms of development innovation from the utilization of this butterfly pea flower. In conducting a bibliometric analysis of Bunga Telang, the authors collect relevant literature using the Scopus database and then use the bibliometric VOS viewer software, to analyze documents and visualize the results to create maps and networks that show trends, themes, and patterns of collaboration in Bunga Telang research.

Picture1. Butterfly flower photo

## 2. Method

In this paper, the researcher adopts a bibliometric analysis that consists of five stages, namely: determining keywords, initial search, and improving search results; Compile initial data statistics (before and after improvement) and saving in RIS format; Enter RIS data into Publish or Perish; Analysis of publication sources and citations; and finally visualize the results using Researcher's VoS Viewer.

The remainder of this article is organized as follows. In the second part, the researcher introduces the concept of innovative research opportunities in tourism, bibliometric analysis, and Scopus as a provider of research data. Followed by explaining the research methodology that the researchers propose. present the results of the Researcher and followed by a full discussion. Finally, the Researcher concludes the Researcher's work and highlights future work. Figure 1 below illustrates the flowchart of the method that the researcher proposes.

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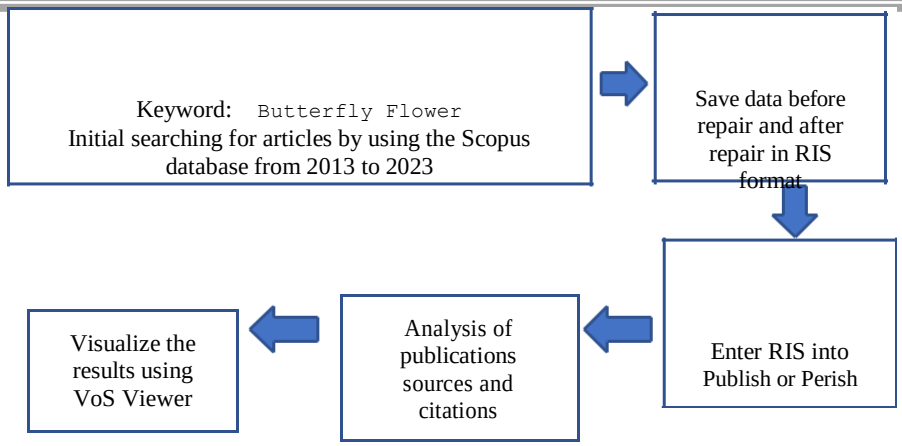


Picture2. Flow chart of the proposed method

### 2.1. Determining the keywords, initial searching, and repairing searching results

The phrase used in this research is Butterfly Pea with a search by title and conducted in June 2023. The data search used the Scopus database for the last 10 years, namely from 2013 to 2023. At the beginning of the search, researchers found articles in a total of 215 documents. The documents in the initial search results are used to compare matrix citations with the documents after the repair. Of the 215 articles obtained the search started from the Scopus database, then after filtering to get relevant results, and finally 207 documents were obtained for further analysis using Publish and Peris &; VOS Viewer.

### 2.2. Compiling and saving data in RIS format

The data has been updated and filtered above, then checked again for the completeness components of the journal articles and reviews including year of publication, volume, number/issue, and pages. Bibliographical data collection in this study was accessed via the Scopus database in May 2023.

### 2.3. Enter RIS data into Publish or Perish

Initial search data and data after repairs are stored in the form of RIS files and then the authors use Publish or Perish for further bibliometric analysis.

### 2.4. Analysis of publications sources and citations

In this section, the author uses Publish or Perish in presenting results on citation analysis, publication sources, document types, journal names and ratings, publisher names and ratings, topic trends, and author collaboration.

### 2.5. Visualizing the results using VoS Viewer Researcher

The researcher's Vos Viewer software was used to visualize topic areas using network visualization; topic areas using overlay visualizations; The topic area uses density visualization, authorship uses overlay visualization, and the researcher's country visualization. The following section presents the results that the researcher obtained in detail and is followed by a discussion.

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## 3. Result and Discussion

This section explains the results obtained from this work, which includes publications and citations, visualizations, authors and networks, research locations, and research domains.

### 3.1. Publications and citations

For knowing compare the citation matrix with the data taken via Scopus, make the table containing the number of articles, number of citations, number of citations per year, number of authors per year, H index researcher, G index, normal hI, and hI yearly at the beginning search and on results repair. A comparison of the data matrix in result search start and result search after repair can be seen in Table 1.

Table1. Comparison Matrix

| Data | Initial Search Results | Search Results Repair |
|---|---|---|
| Databases | Scopus | Scopus |
| Year published | (2013-2023) | (2013-2023) |
| Year citation | 10 | 10 |
| Number of Articles | 215 | 207 |
| Number citation | 1812 | 1808 |
| Number of Citations per Year | 181.20 | 180.80 |
| Number of Authors per Year | 4.45 | 4.47 |
| H Index | 22 | 22 |
| G index | 37 | 37 |
| hI Normal | 10 | 10 |
| hI Annual | 1.00 | 1.00 |

An initial search was conducted on the Scopus database between 2013 and 2023, yielding a total of 215 articles. After going through the revision process, the number of articles was reduced to 207. Even so, the number of citations in both stages remained relatively high, namely 1812 in the initial results and 1808 after the revision. The average number of citations per year also shows a similar figure, which is around 181.20 at the initial stage and 180.80 after improvement.

The results of this study indicate that every year, on average, 4.45 authors contribute to articles published in the Scopus database. This reflects that collaborative work in research is quite significant and interrelated. In addition, the H index (H-index) and G index (G-index) which reach a value of 22 indicate that there is an impact from the works published in this butterfly pea study. The normal H index (H-index) and the annual H index (H-index), both have the same value of 10, indicating that the influence profile of research works is consistent each year.

Overall, this butterfly data collection illustrates an active and impactful research trend, in which the number of articles published, citations, and the H and G indices show significant success and contribution in scientific contributions in the period studied, namely the span of 10 years since 2013-2023. Table 2 as follows describes the statistics of related publications each year.

The 1st International Innovation Technology Proceedings
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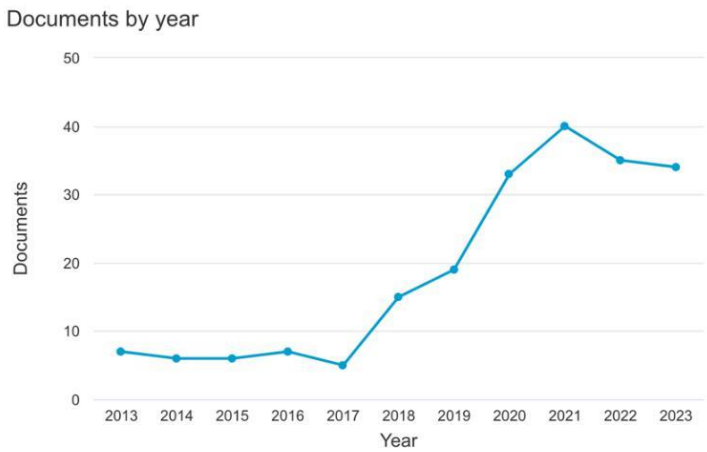
Table2. The statistics descriptive of publications

| year | TP | % (N=207) | NCP | TC | C/P | C/CP |
|---|---|---|---|---|---|---|
| **2013** | 7 | 0.03 | 4 | 64 | 9,14 | 16.00 |
| **2014** | 6 | 0.03 | 4 | 38 | 6,33 | 9.50 |
| **2015** | 6 | 0.03 | 6 | 138 | 23.00 | 23.00 |
| **2016** | 7 | 0.03 | 7 | 208 | 29,71 | 29,71 |
| **2017** | 5 | 0.02 | 5 | 131 | 26,20 | 26,20 |
| **2018** | 15 | 0.07 | 14 | 303 | 20,20 | 21.64 |
| **2019** | 19 | 0.09 | 15 | 257 | 13.53 | 17,13 |
| **2020** | 33 | 0.16 | 26 | 320 | 9.70 | 12.31 |
| **2021** | 40 | 0.19 | 32 | 218 | 5.45 | 6,81 |
| **2022** | 35 | 0.17 | 18 | 69 | 1.97 | 3.83 |
| **2023** | 34 | 0.16 | 7 | 10 | 0.29 | 1.43 |
| | 207 | 100% | | | | |

Note:

TP = total number of publications; NCP = number cited publications; TC=total quotes; C/P=average citations per publication; C/CP= average citations per publication cited

Figure 2 as follows depicts the bar chart of publications and citations.




Picture3. Publications from 2013-2023

The data in Table 2 and the graph in Figure 2 explain the analysis of research results based on the year of publication on a sample of 207 articles. In this analysis, the following parameters are described:

In 2013, there were 7 published articles, accounting for around 0.03% of the total sample of 207 articles. Of these, 4 articles constitute the number of articles cited, with a total of 64 citations. The average citation per article (C/P) this year is around 9.14, while the average citation per publication cited (C /CP) is 16.00.

In 2014 it decreased because there were only 6 articles with a percentage of around 0.03%. Of these, 4 articles constitute the number of articles cited, with a total of 38 citations. The average citation per article (C/P) this year is around 6.33, while the average citation per publication cited (C /CP) was 9.50, but managed to increase in the following two years, namely in 2015 and 2016.

The year 2015 had 6 articles published, accounting for around 0.03% of the total sample. These six articles all constitute the number of articles cited, with a total of 138 citations. The average citations per article (C/P) and the average citations per publication cited (C/CP) this year were 23.00.

In 2016, there were 7 published articles, accounting for around 0.03% of the total sample. all of these articles are also the number of articles cited, with a total of 208 citations. The average citations per article (C/P) and the average citations per publication cited (C/CP) this year were 29.71.

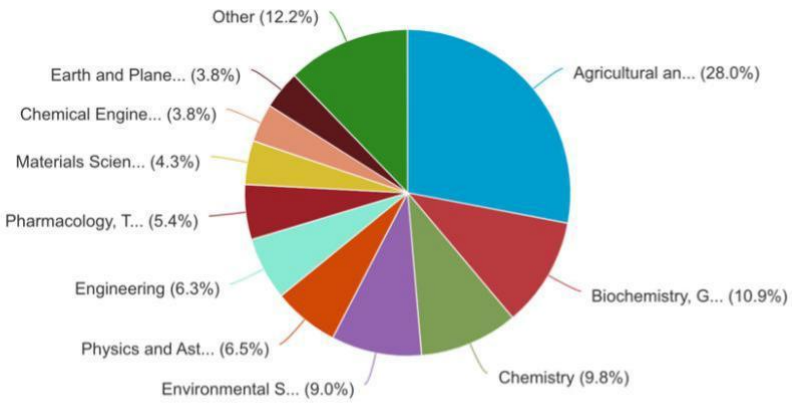
In subsequent years, a similar pattern was found with variations in the number of articles, percentage, collaboration of authors, total citations, as well as the average citations per article and the average citations per publication cited. Finally, in 2023, there are 34 articles with a percentage of 0.16%, of which 7 are citation articles with a total of 10 citations. The average citation per article (C/P) this year is around 0.29, and the average citation per publication cited (C/CP) was 1.43.

2017 has the lowest number of publications and citations in this analysis. In that year, there were 5 published articles, which accounted for about 0.02% of the total 207 articles in the sample. The total number of citations for 2017 is 131. Although the number of publications is low, the number of citations is not the lowest. The average citations per article (C/P) this year was 26.20, and the average citations per publication cited (C/CP) was 26.20. However, publication in 2017 has a significant citation impact per article.

Meanwhile, 2021 has the highest number of publications and citations in this analysis. In that year, there were 40 published articles, accounting for about 0.19% of the total sample. The total number of citations for 2021 is 218. Although the number of publications and citations is very high, the average citations per article (C/P) this year is 5.45, and the average citations per publication cited (C/CP) is 6.81. Even though the number of publications and citations is high, the impact of citations per article is still significant in describing the influence of the articles published in that year.

Overall, the data presented illustrates the trend in the number of articles, the degree of collaboration of authors, and the impact of citations in each year of publication in this butterfly pea study. This data provides a comprehensive picture of the contribution and influence of the articles in various years of research. There was a continuous increase in citations about the butterfly pea flower during the 6 years of the study period.

Figure 3 as follows depicts the documents by subject area.




4Documents by subject area from 2013-2023

The diagram in Figure 3 above analyzes the proportion of subjects in indexed research in the Scopus database. The research data covers various fields of science and the period 2013-2023. The results of the study show that the field of Agricultural and Biological Sciences has the largest proportion with 28% of the total research. This indicates the significance and relevance of understanding plant growth, genetic breeding, and molecular biology in the context of modern agriculture. The fields of Chemistry (9.8%) and Biochemistry, genetics, and molecular biology (10.9%) also play an important role in this scientific research, supporting the development of new compounds and the understanding of the structure and function of biological molecules.

Then, Environmental science (9%) describes concern for environmental issues, including climate change and natural resource conservation. Physics and astronomy (6.5%) contribute to our knowledge of the laws of the universe and astronomical phenomena. Engineering (6.3%) represents an interdisciplinary effort in the development of technologies spanning renewable energy, advanced materials, and complex systems. Pharmacology, toxicology, and pharmaceutics (5.4%) explore the potential applications of pharmaceutical compounds and their toxic risks in the human body. While Materials science (4.3%) focuses on developing new materials with special properties. Earth and planetary science (3.8%) and chemical engineering (3.8%) reflect the exploration of geological and chemical aspects in scientific research. Furthermore,

In conclusion, the distribution of the proportion of science fields in Scopus-indexed research reflects the multidimensional nature of human knowledge. Research in this field contributes to understanding and innovation across sectors, from agriculture to materials technology, with a significant impact on the development of science and society as a whole. The field of science that has the biggest contribution to butterfly pea research is Agricultural and biological science with a total percentage of 28%.

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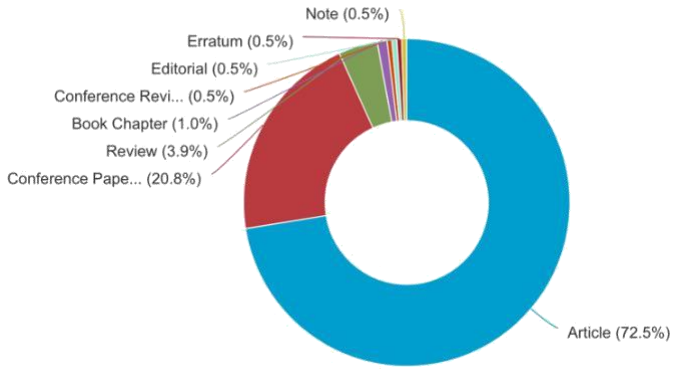



Picture5. Documents by type area from 2013-2023

Table 3 as follows describes the type of documents.

Table3. Type Documents

| type | number | Percentages |
|---|---|---|
| **Articles** | 150 | 0.72 |
| **conference papers** | 43 | 0.21 |
| **Reviews** | 8 | 0.04 |
| **Book chapter** | 2 | 0.01 |
| **Note** | 1 | 0.00 |
| **Erratum** | 1 | 0.00 |
| **Editorial** | 1 | 0.00 |
| **Conference reviews** | 1 | 0.00 |
| | 207 | 100% |

This study comprehensively analyzes the distribution of publication types in the relevant data set. The data analyzed were taken from various reliable sources, to provide a comprehensive picture of the scientific contribution in the relevant domain. A careful data collection methodology has been implemented to ensure the integrity and accuracy of the processed datasets.

In this analysis, a total of 207 published entries were investigated. The results show that the most common type of publication is "Article" with 150 (72%) of the total, confirming the dominance of this literary form in the exploration of the topic in question. Followed by "Conference papers" covering 43 (21%) of the dataset, providing insight into the important contribution of scientific events to knowledge dissemination. Furthermore, several other types of publications make a minor contribution to the overall total. "Review" and "Book chapter" account for 8 (4%) and 2 (1%) publications, respectively, highlighting the important role of critical review as well as contribution in the context of collective publications. In

addition, other entries such as "Note," "Erratum".

The results of this analysis provide a comprehensive picture of the composition of publication types in the studied domain. The implications of this distribution can provide important insights regarding trends in the literature and research focus in relevant areas. By utilizing this analytical framework, this study makes a significant contribution to the understanding of the contribution of publications to scientific development on the subject in question.

Table4. Type Source

| type | number | Percentages |
|---|---|---|
| Journals | 162 | 0.78 |
| Conference Proceedings | 35 | 0.17 |
| book series | 8 | 0.04 |
| book | 2 | 0.01 |
| | 207 | 100% |

In this analysis, the researcher reveals the comprehensive distribution of the various types of publications contained in the relevant data set. The data that the researcher reviewed has been carefully obtained from reliable sources, to provide an in-depth understanding of the contribution of the scientific literature in the domain studied. Rigorous data collection methodologies have been implemented to ensure the integrity and accuracy of the datasets that researchers analyze.

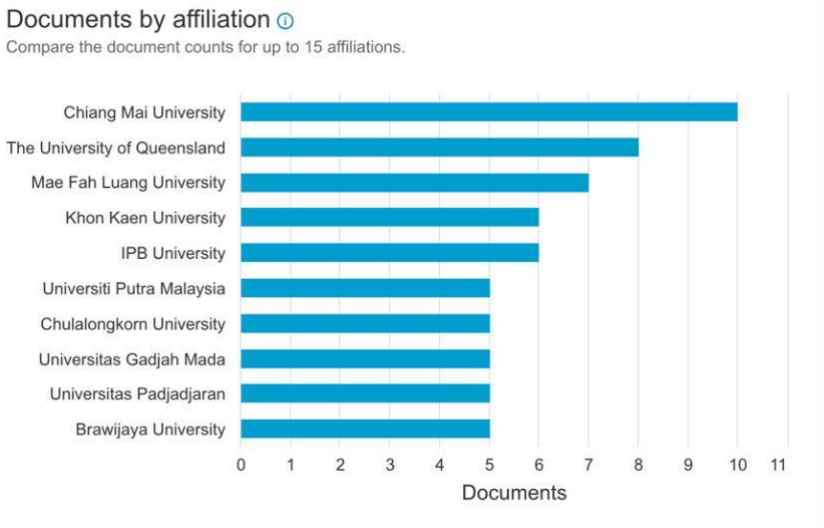
In this dataset, there are a total of 207 publication entries that the researchers reviewed in detail. The researchers' findings indicated that the most common type of publication was "Journal," accounting for 162 (78%) of the total. This fact highlights the significant dominance of scientific journals as the primary form of publication in the exploration and dissemination of knowledge in relevant domains.

Furthermore, researchers identified that "Conference proceedings" also have an important role in scientific contributions, with a total of 35 (17%) entries in the researcher's dataset. This shows that scientific events have a significant impact on shaping scientific literature and provide a platform for the exchange of valuable knowledge.

In addition, the researcher found that "Book series" and "Book" contributed 8 (4%) and 2 (1%) entries in the dataset, respectively. This reflects the diverse role of books and book series in supporting the dissemination of understanding and in-depth knowledge in relevant domains.

The results of this analysis provide valuable insight into the distribution of publication types in the context of this study. The implications of these findings refer to literature trends that can contribute to our understanding of the role of various forms of publication in scientific development in the field concerned. By making use of this analytical framework, this study makes an important contribution to our understanding of the contribution of publications to scientific development in the subject under study.

Figure 5 as follows depicts the documents by affiliation.




Picture6. Documents by affiliate area from 2013-2023

In this analysis, we describe the distribution of institutional affiliation concerning authors in the relevant data set. This institutional affiliation reflects the contribution and involvement of various educational and research institutions in writing scientific literature related to the domain studied. The institutional affiliation data has been carefully analyzed, taking into account the important role of each entity in knowledge sharing.

The results of our analysis show that "Chiang Mai University" is the most commonly appearing institution in the dataset, with a total of 10 (4.83%) affiliations. This institution has a significant contribution to supporting the writing of scientific literature in relevant domains. Furthermore, we identify "The University of Queensland" with a total of 8 (3.86%) affiliations, indicating the institution's important involvement in supporting scientific research and writing in the fields of study.

Likewise, "Mae Fah Luang University," "Khon Kaen University," "IPB University," "University Putra Malaysia," "Chulalongkorn University," "Gadjah Mada University," "Pajajaran University," and "Brawijaya University" respectively each contributed significantly with a total of 7 (3.38%), 6 (2.90%), 6 (2.90%), 6 (2.90%), 5 (2.42%), 5 (2) .42%), 5 (2.42%), 5 (2.42%), and 5 (2.42%) affiliates.

These findings reflect the diversity and diversity of inter-institutional collaboration in supporting research and scientific writing in relevant domains. The implications of this distribution can provide important insights into scientific networks and cross-institutional collaboration in the development of knowledge in the field under study. As such, this study makes a valuable contribution to our understanding of the role of various institutions in scientific and academic development in the relevant subject. Table 5 as follow describes the list of the top 20 cited articles in the related field.

The 1st International Innovation Technology Proceedings
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Table 5. Top 20 cited articles of Butterfly Pea

| No | Cites | Authors | title | year | JournalName | Publishers |
|---|---|---|---|---|---|---|
| 1 | 174 | CA Damalas, SD Koutroubas[8] | Current status and recent developments in biopesticide use | 2018 | Agriculture (Switzerland) | MDPI AG |
| 2 | 95 | N. Noda, S. Yoshioka, S. Kishimoto, M. Nakayama, M. Douzono, Y. Tanaka, R. Aida[9] | Generation of blue chrysanthemums by anthocyanin B-ring hydroxylation and glucosylation and its coloration mechanism | 2017 | Science Advances | American Association for the Advancement of Science |
| 3 | 92 | S. Rawdkuen, A. Fashaha, S. Benjakul, P. Kaewprachu[10] | Application of anthocyanins as a color indicator in gelatin films | 2020 | Food Bioscience | Elsevier Ltd |
| 4 | 87 | GKT Nguyen, Y. Qiu, Y. Cao, X. Hemu, C.-F. Liu, JP Tam[11] | Butelase-mediated cyclization and ligation of peptides and proteins | 2016 | Nature Protocols | Nature Publishing Group |
| 5 | 76 | A. Mehmood, M. Ishaq, L. Zhao, S. Yaqoob, B. Safdar, M. Nadeem, M. Munir, C. Wang[12] | Impact of ultrasound and conventional extraction techniques on bioactive compounds and biological activities of blue butterfly pea flower (Clitoria ternatea L.) | 2019 | Ultrasonics Sonochemistry | Elsevier BV |
| 6 | 69 | V. Nair, WY Bang, E. Schreckinger, N. Andarwulan, L. Cisneros-Zevallos[13] | Protective Role of Ternatin Anthocyanins and Quercetin Glycosides from Butterfly Pea (Clitoria ternatea Leguminosae) Blue Flower Petals against Lipopolysaccharide (LPS)-Induced Inflammation in Macrophage Cells | 2015 | Journal of Agricultural and Food Chemistry | American Chemical Society |
| 7 | 68 | GK Oguis, EK Gilding, MA Jackson, DJ Craik[14] | Butterfly pea (Clitoria ternatea), a cyclotide-bearing plant with applications in agriculture and medicine | 2019 | Frontiers in Plant Science | Frontiers Media SA |
| 8 | 53 | EK Gilding, MA Jackson, AG Poth, ST Henriques, PJ Prentis, T. Mahatmanto, DJ Craik[15] | Gene coevolution and regulation lock cyclic plant defense peptides to their targets | 2016 | New Phytologist | Blackwell Publishing Ltd |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | 52 | H. -J. Kim, S. Roy, J. -W. Rhim[16] | Gelatin/agar-based color-indicator film integrated with Clitoria ternatea flower anthocyanin and zinc oxide nanoparticles for monitoring the freshness of shrimp | 2022 | Food Hydrocolloids | Elsevier BV |
| 10 | 47 | KNT Nguyen, GKT Nguyen, PQT Nguyen, KH Ang, PC Dedon, JP Tam[17] | Immunostimulating and Gram-negative-specific antibacterial cyclotides from the butterfly pea (Clitoria ternatea) | 2016 | FEBS Journal | Blackwell Publishing Ltd |
| 11 | 38 | T. Hiromoto, E. Honjo, T. Tamada, N. Noda, K. Kazuma, M. Suzuki, R. Kuroki[18] | Crystal structure of UDP-glucose: anthocyanidin 3-O-glucosyltransferase from Clitoria ternatea | 2013 | Journal of Synchrotron Radiation | IUCr |
| 12 | 34 | GB Escher, M. Wen, L. Zhang, ND Rosso, D. Granato[19] | Phenolic composition by UHPLC-Q-TOF-MS/MS and stability of anthocyanins from Clitoria ternatea L. (butterfly pea) blue petal | 2020 | Food Chemistry | Elsevier Ltd |
| 13 | 33 | EJ Jeyaraj, YY Lim, WS Choo[20] | Extraction methods of butterfly pea (Clitoria ternatea) flower and biological activities of its phytochemicals | 2021 | Journal of Food Science and Technology | Springer |
| 14 | 31 | P. Jaikang, P. Paengnakorn, K. Grudpan[21] | Simple colorimetric ammonium assay employing well microplate with gas pervaporation and diffusion for natural indicator immobilized paper sensor via smartphone detection | 2020 | Microchemical Journal | Elsevier Inc. |
| 15 | 30 | SK Mary, RR Koshy, J. Daniel, JT Koshy, LA Pothen, S. Thomas[22] | Development of starch-based intelligent films by incorporating anthocyanins of butterfly pea flower and TiO2 and their applicability as freshness sensors for prawns during storage | 2020 | RSC Advances | Royal Society of Chemistry |
| 16 | 30 | W. Xu, A. Anderson[23] | Carbon dioxide receptor genes in cotton bollworm Helicoverpa armigera | 2015 | Science of Nature | Springer Verlag |
| 17 | 27 | MK Bowen, F. Chudleigh, S. Buck, K. Hopkins[24] | Productivity and profitability of forage options for beef production in the subtropics of northern Australia | 2018 | Animal production science | CSIRO |
| 18 | 27 | SBH Hashim, H. Elrasheid Tahir, L. Liu, J. Zhang, X. Zhai, A. Ali Mahdi, F. Nureldin Awad, MM Hassan, Z | Intelligent colorimetric pH censoring packaging films based on sugarcane wax/agar integrated with butterfly pea flower extract for optical | 2022 | Food Chemistry | Elsevier Ltd |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Xiaobo, S. Jiyong[25] | tracking of shrimp freshness | | | |
| 19 | 25 | A. Boonsiriwit, M. Lee, M. Kim, P. Inthamat, U. Siripatrawan, YS Lee[26] | Hydroxypropyl methylcellulose/microcrystalline cellulose biocomposite film incorporated with butterfly pea anthocyanin as a sustainable pH-responsive indicator for intelligent food-packaging applications | 2021 | Food Bioscience | Elsevier Ltd |
| 20 | 24 | C. Chusak, JAY Ying, JL Zhien, P. Pasukamonset, CJ Henry, S. Ngamukote, S. Adisakwattana[27] | Impact of Clitoria ternatea (butterfly pea) flower on in vitro starch digestibility, texture, and sensory attributes of cooked rice using domestic cooking methods | 2019 | Food Chemistry | Elsevier Ltd |

The data presented is a collection of the 20 most cited articles in the context of the butterfly pea flower (Clitoria ternatea). This analysis illustrates the contribution of scientific articles that are significant in expanding the understanding of various aspects related to the butterfly pea flower in the scientific literature. One of the top articles reviewed[28] is the current status and recent developments in the use of biopesticides, highlighting the importance of using environmentally friendly alternatives in agricultural pest control.

Another article[29] discusses the manufacture of blue chrysanthemum through hydroxylation and glocalization of anthocyanins, as well as the coloring mechanism. These findings provide insight into the genetic and chemical modifications that make it possible to develop ornamental plants with different colors. Some articles describe[30] the application of anthocyanins as color indicators in gelatin films, with their potential use in food packaging. This highlights the potential of the butterfly pea flower in creating innovation in the food industry.

Other research[31] focuses on the butelase enzyme used in the cyclization and ligation of peptides and proteins. This study illustrates[32] innovative biotechnology applications in molecular manipulation. There is also research[33]regarding the biological activity of the butterfly pea flower, including its role in fighting inflammation and[34] cell protection in the body's immune response.

The results of this analysis reflect the contribution of various articles in developing an understanding of the butterfly pea flower, ranging from[35]agricultural applications and[36]biotechnology to potential use in the food industry and[37]packaging. These articles draw on in-depth research interdisciplinarities and make important contributions to our understanding of the potential of this plant in various contexts of scientific research and application.

Table 6 as follow describes the top five publishers in the related field. Table6.

The 1st International Innovation Technology Proceedings
Vol 1 No 1 (2023): October
E-ISSN: 3030-9948
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Top five publishers in the related field

| No | Publishers | Number of Articles | Percentages |
|---|---|---|---|
| **1** | Elsevier | 31 | 0.39 |
| **2** | Springer | 14 | 0.18 |
| **3** | MDPI | 14 | 0.18 |
| **4** | IOP Publishing Ltd | 13 | 0.16 |
| **5** | American Institute of Physics Inc. | 8 | 0.10 |
| | | 80 | 100% |

The data above represents the distribution of publications (publishers) of relevant articles in the research context. The analysis provides an overview of the role and contribution of each publisher in publishing scientific literature related to the topic of butterfly peas. In this analysis, publisher Elsevier has the most dominant role with a total of 31 articles (0.39% of the total), reflecting a significant contribution in presenting and disseminating scientific knowledge related to research. Publications from Elsevier publishers illustrate a wide range of viewpoints and approaches to topics.

Springer Publishers and MDPI have equivalent contributions of 14 articles each (0.18% of the total). The two publishers also have an important role to play in supporting scientific research on this topic by providing a diverse and relevant publication platform. Furthermore, IOP Publishing Ltd and the American Institute of Physics Inc. each contributed 13 (0.16%) and 8 (0.10%) articles. The contributions of these publishers also add multiple dimensions to the existing scholarly literature, highlighting a focus on aspects of the physical sciences and related fields.

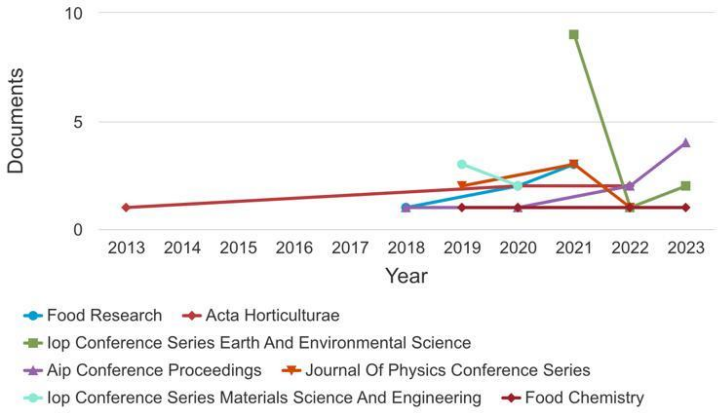
Overall, the results of the analysis provide an understanding of the distribution of publications in this domain, by illustrating the role of various publishers in supporting scientific research on the topics studied. The implications of this distribution can provide insight into trends in scientific publications and collaborations in related literature. Thus, this analysis makes a valuable contribution to the understanding of the contribution of publications from various publishers in the scientific development of this subject. Table 7 as follow describes the top five journals in the related field.

Table7. Top five journals ranking

| No | JournalName | Number of Articles | Percentages |
|---|---|---|---|
| 1 | IOP Conference Series Earth and Environmental Science | 12 | 0.32 |
| 2 | AIP Conference Proceedings | 8 | 0.22 |
| 3 | IOP Conference Series: Earth and Environmental Science | 6 | 0.16 |
| 4 | FoodResearch | 6 | 0.16 |
| 5 | Acta Horticulture | 5 | 0.14 |
| | | 37 | 100% |

The 1st International Innovation Technology Proceedings
Vol 1 No 1 (2023): October
E-ISSN: 3030-9948
https://iite-proceeding.poltekindonusa.ac.id

Figure 6 as follows depicts the documents per year by source.




Picture7. Documents by source area from 2013-2023

The data describes the distribution of journals or series of journals that have published scientific articles relevant to the scope of this research. This analysis provides an overview of the contributions of each journal in publishing scientific literature related to the topic under investigation. In this analysis, "IOP Conference Series Earth and Environmental Science" has the most dominant role with a total of 12 articles

(0.32% of the total), illustrating the important role of this journal in supporting and presenting scientific knowledge in the field of earth and environmental sciences.

The journal series "AIP Conference Proceedings" also has a significant contribution with 8 articles (0.22% of the total). The journal also plays an important role in supporting research and presenting scientific results from related scientific conferences and events. Furthermore, "Food Research" and "Acta Horticulture" published 6 (0.16%) and 5 (0.14%) articles respectively. The contributions of these journals reflect a focus on the scientific aspects of food and horticulture and the important role they play in providing scientific understanding in this context.

Overall, this analysis provides an understanding of the distribution of publications in this domain, by highlighting the contribution of various journals in supporting scientific research on the topic investigated. The implications of this distribution can provide insight into publication trends in relevant fields and the role of each journal in scientific development. Thus, this analysis makes a valuable contribution to our understanding of the contribution of publications from various journals in the scientific development of this subject.

The 1st International Innovation Technology Proceedings
Vol 1 No 1 (2023): October
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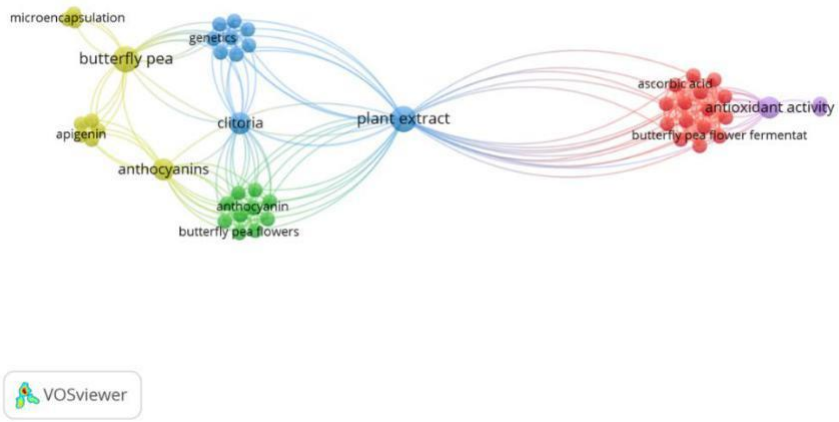
https://iite-proceeding.poltekindonusa.ac.id

### 3.2. Visualization topics use VoS Viewer

Figure 7 below shows a visualization of topic areas using network visualization from VoS Viewer.




Picture8. Visualization of topic areas using network visualization

The network visualization of the data above illustrates the clustering (grouping) of keywords that appear in scientific articles relevant to this research topic. This visualization helps identify patterns and relationships between keywords that have thematic linkages.

The "Red" cluster consists of 15 items related to the process of fermenting butterfly pea flowers, increasing ascorbic acid, and fermentation as a method. This cluster highlights the focus on the application of fermentation technology for the processing of butterfly pea flowers and its potential to increase ascorbic acid content.

The "Green" cluster consists of 10 items related to the flower of the butterfly pea, anthocyanins, and floral characteristics. This cluster emphasizes the importance of anthocyanins contained in the flower of the butterfly pea flower and its potential in terms of the characteristics and properties of the flower itself.

The "Blue" cluster consists of 10 items related to plant extracts, studies on Clitoria plants, and genetics. This cluster demonstrates an interest in genetic research and the extraction of compounds from Clitoria plants.

The "Yellow" cluster consists of 10 items related to the anthocyanin in the butterfly pea flower, the compound content of the butterfly pea, and the apigenin compound. This cluster underscores the importance of anthocyanins and related compounds in the pea flower and their potential in chemical and functional studies.

The 1st International Innovation Technology Proceedings
Vol 1 No 1 (2023): October
E-ISSN: 3030-9948
https://iite-proceeding.poltekindonusa.ac.id

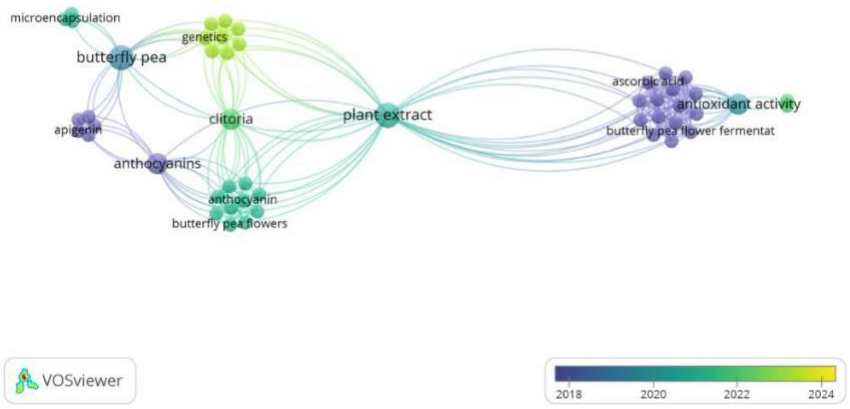
The "Purple" cluster consists of 3 items that focus on antioxidant activity and the effect of modified atmosphere on storage. This cluster highlights the role of butterfly pea flowers in the development of products with antioxidant properties and the role of modified atmosphere in maintaining quality.

Table8. Item number in clusters

| Clusters | color | Number of Items | Representative keywords |
|---|---|---|---|
| 1 | red | 15 | Butterfly pea flower fermentation, ascorbic acid, fermentation |
| 2 | Green | 10 | Butterfly pea flower, anthocyanin, flower |
| 3 | Blue | 10 | Plant extract, clitoria, genetics |
| 4 | Yellow | 10 | Anthocyanins, butterfly pea, apigenin |
| 5 | purple | 3 | Antioxidant activity, modified atmosphere |

This network visualization helps to understand the pattern of associations between keywords in the scientific literature, identify relevant topic groups, and provide a more comprehensive view of various aspects of research related to the butterfly pea flower in various scientific contexts.

Figure 8, as follows, describes the visualization of the topic area using overlay visualization from VoS Viewer.




Picture9. Visualization of topic areas using overlay visualization

The overlay visualization of the data above illustrates the relationship between keywords that appear in scientific articles at different timeframes. Overlay visualization helps identify trends and changes in research focus from year to year. Keywords that have lighter nodes are keywords used in younger years.

In the 2018-2019 timeframe, the research focus involved keywords such as "Apigenin," "Anthocyanins," "Butterfly pea flower fermented," and "Ascorbic acid." This shows the attention to research on apigenin and anthocyanin compounds in butterfly pea flowers, as well as the application of fermentation and its effect on ascorbic acid content.

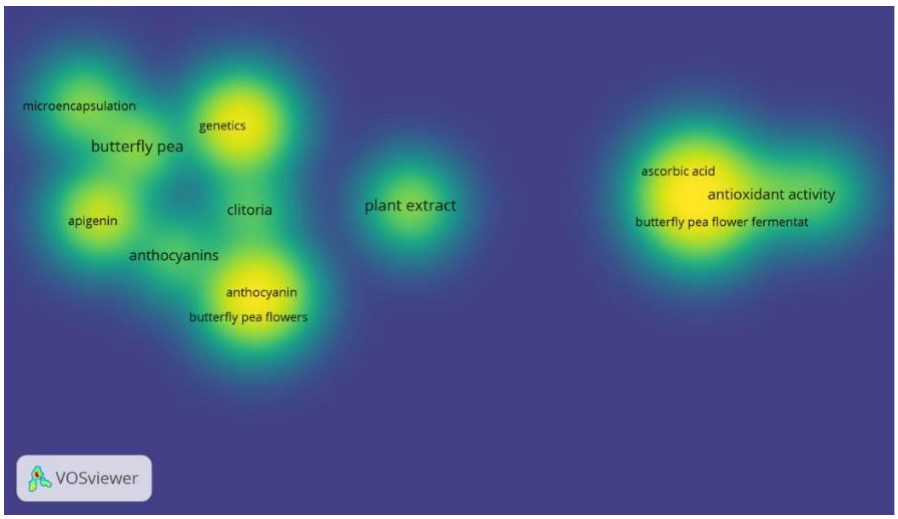
The 1st International Innovation Technology Proceedings
Vol 1 No 1 (2023): October
E-ISSN: 3030-9948
https://iite-proceeding.poltekindonusa.ac.id

In the 2020-2021 period, the keywords that appeared were "Butterfly pea," "Antioxidant activity," "Plant extract," "Anthocyanins," "Butterfly pea flowers," and "Microencapsulation." This visualization illustrates a shift in research focus towards research on the potential of antioxidants in butterfly pea flowers, and plant extracts, as well as microencapsulating techniques for product development.

In 2022-2023, attention shifts to the buzzwords "Genetics," "Clitoria," and "Modified atmosphere." This shows an emphasis on the genetic aspects of Clitoria plants, as well as research on modified atmospheres in product storage involving the butterfly pea flower.

This overlay visualization helps us understand how the research focus has evolved, and identify trends, and changes in research areas related to the telang flower. This provides insight into the evolution of scientific knowledge and interest over different timescales

Figure 9, as follows, describes the visualization of the topic area using density visualization from VoS Viewer.




Picture10. Visualization of topic areas using density visualization

Lighter-colored nodes indicate that the keyword has a more significant presence and appears more frequently in scholarly articles. In the context of the data provided, keywords that have lighter node colors, such as "Butterfly pea flowers," "Anthocyanins," "Ascorbic acid," "Butterfly pea flower fermented," and "Genetics," indicate that these topics have stronger focus and attention in the scientific literature. The existence and distribution of these keywords are denser than other keywords.

This density visualization provides an intuitive view of the distribution of keywords in the scientific literature and helps identify the most salient and important topic areas in research related to the butterfly pea flower. This helps to understand the level of attention and significance of each topic in the scientific literature and its potential contribution to knowledge development and research in this field.

The 1st International Innovation Technology Proceedings
Vol 1 No 1 (2023): October
E-ISSN: 3030-9948
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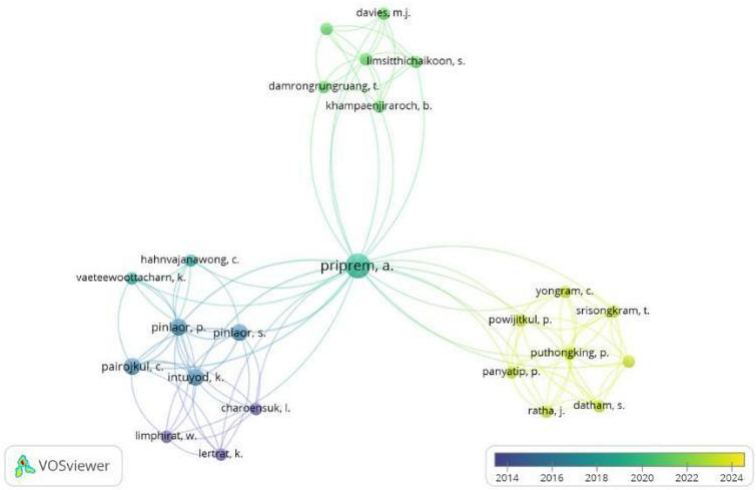
### 3.3. Author and Relationship between Writers

Figure 10 below depicts an overlay visualization of the author and co-author using the VoS Viewer.




Picture11. Visualization of the author and co-author overlay

In this analysis, several authors have contributed significantly to publications related to the topic under study. The author with the most contributions is Priprem, A., who has a total of 4 published documents. This author demonstrates a high level of productivity in creating scientific content, with a total strength link of 27. The publication average of Priprem, A in 2019 marks its main focus in this period, which may reflect a significant increase in research and scientific contributions.

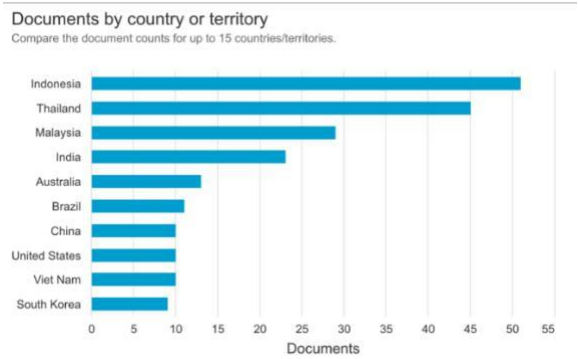
Furthermore, there is a group of writers who have the second most publications, namely Pinlaor, P, Pinlaor, S, Intuyod, K, and Pairojkul. Each author in this group has 2 published documents, with a total link strength of 13. The average year of publication for this group is 2016. This indicates that this group of authors has contributed simultaneously to several publications in the same year, indicating collaboration and close scientific cooperation. In addition, there are other authors who each have 1 publication document. Although their contributions were limited in several publications, they remained important in enriching the scientific literature on this topic.

This analysis reflects the structure of the collaboration and contribution of the authors in the scientific literature regarding the topics studied. The authors with the most contributions demonstrated their commitment and dedication to advancing scientific understanding in this field. In addition, the collaboration between the authors in the second group of publications signifies a valuable collaborative

relationship in the pursuit of enriching knowledge on this topic. All of these contributions collectively help broaden and deepen our understanding of the topic under study.

### 3.4. Research Locations and Research Domains

Figure 11 below depicts the author's country of origin.




Picture12. Country of origin

Figure 12 below depicts the map of the author's country of origin.


Picture13. Map of country of origin (Please use https://mapchart.net/)

Based on Figure 12 above, shows that Indonesia is leading in research contributions with a total of 51 publications, confirming a significant role in producing scientific literature related to this topic. This reflects the strong level of involvement of Indonesian researchers in advancing scientific understanding in the domain investigated. Furthermore, Thailand and Malaysia also made important contributions with 45 and 29 publications respectively. The contributions from these two countries show significant involvement in this field of research, with collaborations between researchers from various institutions inside and outside the country.

India, Australia, Brazil, China, the United States of America, Vietnam, and South Korea also contributed to this scientific literature. The contributions of these countries reflect the rich and diverse aspects of international collaboration in the investigation of relevant topics. In this context, the research

connects researchers from various cultural and scientific backgrounds, enriching insights and cross-border understanding of the topics studied.

The importance of these contributions from various countries is a reflection of global efforts in developing and disseminating scientific knowledge. Cooperation between these countries has had a positive impact on research developments in this domain, helping to broaden the scope and depth of scientific knowledge relevant to the topics investigated.

Table 9 below presents the country of research location and their respective research domain.

Table9. Top 10 Countries of location research and research Domain

| No | Country | Number of Articles | Research Domains |
|---|---|---|---|
| 1 | Indonesia | 51 | Clitoria Ternatea, butterfly pea, Anthocyanins, flavonoids, antioxidants, Plant Extracts, Flowers |
| 2 | Thailand | 45 | Clitoria Ternatea, Anthocyanin, butterfly pea, antioxidants, plant extract, color, Unclassified Drug |
| 3 | Malaysia | 29 | Clitoria Ternatea, butterfly pea, extract, Anthocyanin, Unclassified Drug, plant extract, antioxidants, flower |
| 4 | India | 23 | Clitoria Ternatea, Unclassified Drug, plant extract, Clitoria Ternatea Extract, Methanol, Flavonoids, color |
| 5 | Australia | 13 | Clitoria Ternatea, Legume, Centrosema, Hexapoda, Grass, Suppressive Plants, Biomass, Plant Proteins |
| 6 | Brazil | 11 | Clitoria Ternatea, Clitoria, Chemistry, Seeds, Plant Seed, plant extract, Pennisetum Purpureum, color |
| 7 | China | 10 | Clitoria Ternatea, color, plant extract, Anthocyanins, antioxidants, flower |
| 8 | united states | 10 | Clitoria Ternatea, plant extract, Medicinal, Flavonoids, Butterfly Pea, Sugars |
| 9 | Viet Nam | 10 | Clitoria Ternatea, Extraction, Anthocyanins, Butterfly Pea Flowers, Butterfly Pea |
| 10 | South Korea | 9 | Clitoria Ternatea, Anthocyanins, Plant Extract, Flower, Butterfly Pea |

This research has involved contributions from ten countries with diverse research locations, which collectively form a rich and diverse scientific landscape in the investigation of the topics described. The following describes the top ten countries in research locations and relevant research domains:

3.4.1. Indonesia (51 articles): Indonesia stands out in research related to Clitoria Ternatea, butterfly peas, Anthocyanins, flavonoids, antioxidants, Plant Extracts, and Flowers. Research from Indonesia has contributed significantly to deepening the understanding of the chemical characteristics and functionality of the butterfly pea flower plant and its potential use in various contexts.

3.4.2. Thailand (45 articles): Thailand has also played an important role in the investigation of Clitoria Ternatea, Anthocyanin, butterfly pea, antioxidants, plant extract, color, and Unclassified Drugs. Research from Thailand has focused on the analysis of chemical compounds and the potential application of butterfly pea flowers in the context of phytotherapy and nutraceuticals.

3.4.3. Malaysia (29 articles): Malaysia contributed to the study of Clitoria Ternatea, butterfly pea, extract, Anthocyanin, Unclassified Drug, plant extract, antioxidants, and flower. Research from Malaysia explored the nutritional properties and bioactive potential of the butterfly pea flower plant, with a focus on the extraction of important compounds.

3.4.4. India (23 articles): India focuses its research on Clitoria Ternatea, Unclassified Drugs, plant extract, Clitoria Ternatea Extract, Methanol, Flavonoids, and color. Research from India has been in-depth in the analysis of active compounds in butterfly pea flowers and their potential applications in medicine and industry.

3.4.5. Australia (13 articles): Australia has contributed to research on Clitoria Ternatea, Legume, Centrosema, Hexapoda, Grass, Suppressive Plants, Biomass, and Plant Proteins. Research from Australia tends to be related to the analysis of the ecology and physiology of the butterfly pea flower and its role in ecosystems and agriculture.

3.4.6. Brazil (11 articles): Research from Brazil focuses on Clitoria Ternatea, Clitoria, Chemistry, Seeds, Plant Seed, plant extract, Pennisetum purpureum, and color. This research includes the analysis of chemical compounds and the potential use of the butterfly pea flower in a chemical and industrial context.

3.4.7. China (10 articles): China focuses on Clitoria Ternatea, color, plant extract, Anthocyanins, antioxidants, and flowers. Research from China highlights the properties of natural dyes and antioxidant compounds in butterfly pea flowers.

3.4.8. United States (10 articles): Research from the United States focused on Clitoria Ternatea, plant extract, Medicinal, Flavonoids, Butterfly peas, and Sugars. This research involves an analysis of the active compounds in the butterfly pea flower and its potential application in medicine.

3.4.9. Viet Nam (10 articles): Vietnam plays a role in research on Extraction, Anthocyanins, Butterfly Pea Flowers, and Butterfly Pea. Research from Vietnam tends to be related to the extraction of bioactive compounds from butterfly pea flowers and their potential use in health applications.

3.4.10. South Korea (9 articles): South Korea focuses on Clitoria Ternatea, Anthocyanins, Plant Extract, Flower, and Butterfly Pea. Research from South Korea explored the biochemical properties and potential applications of butterfly pea flowers in various contexts.

Taken together, these contributions from various countries provide a comprehensive and diverse view of research topics relevant to Clitoria Ternatea. Cross-country cooperation in this investigation makes an important contribution to developing global knowledge and understanding of the butterfly pea flower and its potential application in various scientific fields.

## 4. Conclusion

The use and utilization of the Telang Flower innovation have not been widely studied before on an international scale. This paper has succeeded in presenting a bibliometric analysis related to butterfly pea research trends and collaborations in various classified scientific fields along with the trend models that occur. The researcher obtained the result that the majority of related articles were published in scientific journals, compared to other venues. Related articles published in scientific journals have obtained the highest citations compared to others.

The advice given is that in subsequent research it is necessary to study more broadly the use of butterfly pea flowers and sustainable innovation by communities based on micro, small, and medium enterprises (MSMEs) in tourist village areas. This research is also expected to be used as a basic reference to see how data visualization is in finding research trends that are being developed. Of course, by implementing the use of a complete bibliometric method and with more elements used, learning and using software tools can produce more compressed data.

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