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Bibliometric Analysis of Computational Mapping in The Publication of Nano Propolis using VOSviewer

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Abstract. Previous research has shown that propolis contains natural ingredients such as antibacterial, antifungal and anti-inflammatory activities. With a lot of content and benefits for health, further research is needed on nanoparticles in propolis. This research was conducted to determine the development of studies on nano propolis in the last 10 years. The data used in this study comes from indexed articles that have been published on Google Scholar. The software used for data processing is Publish or Perish for data filtering and VOSviewer for visualization of bibliometric computational. The results showed that there were 1000 articles that matched the criteria, and it was found that nano propolis is divided into 3 main fields, namely nanoparticles, propoli, and propolis. Based on data mapping, it can be seen that there is an increase in research on nanopropolis around 2019-2020. This review can be a starting point for further research related to nanopropolis.

Keywords: Bibliometric, Nano Propolis, VOSviewer

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1. Introduction

In this era, many people are starting to become health conscious and look for natural alternative ingredients to help maintain a healthy body. One of the natural ingredients that are widely used for health is propolis. Propolis is a resin mixture produced by honey bees from plant exudates, has a complex chemical composition that has actually been used by previous generations as medicine[1]. Propolis is a material that is rich in flavonoids, phenolic acids and is a terpene derivative. With the content of compounds like this propolis can work as an ingredient with antibacterial, antifungal and anti-inflammatory properties. Chemical analysis has shown interesting molecules in propolis that also present interesting anti-oxidant and anti-proliferative properties in the field of anti-cancer therapy[2]. Unfortunately, it is still not certain whether the field of research on propolis is in great demand or not, especially in the field of nanopropolis research.

To determine the development of research in the field of nano propolis, blibiometric analysis can be used. Bibliometric analysis is a form of meta-analysis of research data that can assist researchers in

studying bibliographic content and citation analysis from articles published in journals and other scientific works[3]. The collected bibliometric data can be processed using a simple data processing application.

Previously, there were many studies that used bibliometric analysis, including bibliometric analysis in the field of education[3], bibliometric analysis in the field of economics[4], bibliometric analysis in the field of health[5]. However, research on computational mapping of bibliometric analysis of published data in the field of nano propolis to determine the development of research has not been carried out. Therefore, this study aims to carry out computational research and mapping bibliometric analysis of articles that have been indexed on google scholars using VOSviewer software. It is hoped that this research can be a reference for researchers to conduct and determine the research themes to be taken, especially those related to nano propolis.

2. Methods

2.1. Data Collection

The data used in this study comes from articles that have been indexed and have been published on Google Scholar. Article data will be collected using the Publish or Perish reference manager application. Information on how to use the Publish or Perish application is obtained from articles published by Azizah et al. [6] Keywords used to filter publications were "nano propolis" and "nanoparticle". The article data used in this study came from journals published in 2012 to 2022.

2.2. Blibiometric data processing using Microsoft Excel

The data obtained from the Publish or Perish application is exported into two types of files: reasearch information system format (.ris) and comma separated value format (*.csv). The data collected from the metadata will contain the author's name, title, year, journal name, publisher, number of citations, article links, and related URLs.

2.3. Computational mapping analysis of bibliometric published data using the VOSviewer software

Article data from the source database was mapped using VOSviewer to create 3 variations of mapping publications, namely network visualization, density visualization, and overlay visualization based on the network (co-citation) between existing items. When creating a bibliometric map, the keyword frequency is set to be found at least 3 times. Therefore, 281 less relevant terms and keywords were removed.

3. Result and Discussion

3.1. Data collection results

Based on the search data on the Publish or Perish reference application from the Google Scholar database, 1000 article data met the research criteria. **Table 1** shows some examples of published data used in the VOSviewer analysis in this study. The data samples taken were 50 articles most related to the topic of nano propolis. The number of citations from all articles used in this study is 21350, the number of citations per year is 2135.00, the number of citations per article used is 21.35, the average author in the articles used is 3.78, all articles have an average h-index of 71, and a g-index of 111.

Table 1. The most cited nano propolis publication data

No	Authors	Title	Year	Cites	Refs
1	H Wang, J Qian, F Ding	Emerging chitosan-based films for food packaging applications	2018	429	[7]

2	CJM Rivas, M Tarhini, W Badri, K Miladi…	Nanoprecipitation process: From encapsulation to drug delivery	2017	337	[8]
3	A Alexander, RJ Patel, S Saraf, S Saraf	Recent expansion of pharmaceutical nanotechnologies and targeting strategies in the field of phytopharmaceuticals for the delivery of herbal extracts and bioactives	2016	118	[9]
4	MG Morais, VG Martins, D Steffens…	Biological applications of nanobiotechnology	2014	93	[10]
5	MO Wassel, MA Khattab	Antibacterial activity against Streptococcus mutans and inhibition of bacterial induced enamel demineralization of propolis, miswak, and chitosan nanoparticles based dental varnishes	2017	92	[11]
6	P Szweda, K Gucwa, E Kurzyk, E Romanowska…	Essential oils, silver nanoparticles and propolis as alternative agents against fluconazole resistant Candida albicans, Candida glabrata and Candida krusei Clinical Isolates	2015	91	[12]
7	IPS Fernando, WW Lee, EJ Han, G Ahn	Alginate-based nanomaterials: Fabrication techniques, properties, and applications	2020	90	[13]
8	A Ullah, S Ullah, MQ Khan, M Hashmi, PD Nam…	Manuka honey incorporated cellulose acetate nanofibrous mats: Fabrication and in vitro evaluation as a potential wound dressing	2020	88	[14]
9	NM Elbaz, IA Khalil, AA Abd-Rabou…	Chitosan-based nano-in-microparticle carriers for enhanced oral delivery and anticancer activity of propolis	2016	75	[15]
10	S Derman	Caffeic acid phenethyl ester loaded PLGA nanoparticles: effect of various process parameters on reaction yield, encapsulation efficiency, and particle size	2015	74	[16]
11	R Conte, V Marturano, G Peluso, A Calarco…	Recent advances in nanoparticle-mediated delivery of anti-inflammatory phytocompounds	2017	71	[17]
12	S Sharaf, ME El-Naggar	Wound dressing properties of cationized cotton fabric treated with carrageenan/cyclodextrin hydrogel loaded with honey bee propolis extract	2019	70	[18]
13	S Sabra, DM Ragab, MM Agwa, S Rohani	Recent advances in electrospun nanofibers for some biomedical applications	2020	63	[19]
14	A Eskandarinia, A Kefayat, M Gharakhloo…	A propolis enriched polyurethane-hyaluronic acid nanofibrous wound dressing with remarkable antibacterial and wound healing activities	2020	61	[20]
15	K Khoshnevisan, H Maleki, H Samadian…	Antibacterial and antioxidant assessment of cellulose acetate/polycaprolactone nanofibrous mats impregnated with propolis	2019	58	[21]

16	R Liu, D Ji, G Zhou, Z Liu, Q Xu…	Electrospun nanofibers for personal protection in mines	2021	58	[22]
17	M Rezaeigolestani, A Misaghi, A Khanjari…	Antimicrobial evaluation of novel poly-lactic acid based nanocomposites incorporated with bioactive compounds in-vitro and in refrigerated vacuum-packed cooked …	2017	56	[23]
18	M Kurakula, GSNK Rao	Moving polyvinyl pyrrolidone electrospun nanofibers and bioprinted scaffolds toward multidisciplinary biomedical applications	2020	49	[24]
19	A Kamkar, E Molaee-Aghaee, A Khanjari…	Nanocomposite active packaging based on chitosan biopolymer loaded with nano-liposomal essential oil: Its characterizations and effects on microbial, and chemical …	2021	48	[25]
20	T Mehdizadeh, AM Langroodi	Chitosan coatings incorporated with propolis extract and Zataria multiflora Boiss oil for active packaging of chicken breast meat	2019	48	[26]
21	Y Wu, YH Li, XH Gao, HD Chen	The application of nanoemulsion in dermatology: an overview	2013	48	[27]
22	KM Kamel, IA Khalil, ME Rateb, H Elgendy…	… /oregano-loaded solid lipid nanoparticles to augment 5-fluorouracil cytotoxicity for colorectal cancer: extract standardization, nanoparticle optimization, and cytotoxicity …	2017	44	[28]
23	AD Permana, RN Utami, AJ Courtenay…	Phytosomal nanocarriers as platforms for improved delivery of natural antioxidant and photoprotective compounds in propolis: An approach for enhanced both …	2020	42	[29]
24	ES Abamor	Antileishmanial activities of caffeic acid phenethyl ester loaded PLGA nanoparticles against Leishmania infantum promastigotes and amastigotes in vitro	2017	42	[30]
25	A Stähli, CU Maheen, FJ Strauss, S Eick…	Caffeic acid phenethyl ester protects against oxidative stress and dampens inflammation via heme oxygenase 1	2019	41	[31]
26	L Moradkhannejhad, M Abdouss, N Nikfarjam…	Electrospinning of zein/propolis nanofibers	2018	39	[32]
27	P Tatli Seven, I Seven, B Gul Baykalir…	Nanotechnology and nano-propolis in animal production and health: An overview	2018	37	[33]
28	M Contardi, D Kossyvaki, P Picone, M Summa…	Electrospun polyvinylpyrrolidone (PVP) hydrogels containing hydroxycinnamic	2021	36	[34]

		acid derivatives as potential wound dressings			
29	M Azarifar, B Ghanbarzadeh, A Abdulkhani	The effects of gelatin-CMC films incorporated with chitin nanofiber and Trachyspermum ammi essential oil on the shelf life characteristics of refrigerated raw beef	2020	33	[35]
30	LD Pérez-Vergara, MT Cifuentes, AP Franco…	Development and characterization of edible films based on native cassava starch, beeswax, and propolis	2020	33	[36]
31	M Azarifar, B Ghanbarzadeh, A Abdulkhani	The effects of gelatin-CMC films incorporated with chitin nanofiber and Trachyspermum ammi essential oil on the shelf life characteristics of refrigerated raw beef	2020	33	[35]
32	E Adomavičiūtė, S Pupkevičiūtė, V Juškaitė…	Formation and investigation of electrospun PLA materials with propolis extracts and silver nanoparticles for biomedical applications	2017	32	[37]
33	M Yousefi, N Khorshidian, AM Mortazavian…	Preparation optimization and characterization of chitosan-tripolyphosphate microcapsules for the encapsulation of herbal galactagogue extract	2019	32	[38]
34	S Khaledi, S Jafari, S Hamidi, O Molavi…	Preparation and characterization of PLGA-PEG-PLGA polymeric nanoparticles for co-delivery of 5-Fluorouracil and Chrysin	2020	31	[39]
35	O Catchpole, K Mitchell, S Bloor, P Davis…	Anti-gastrointestinal cancer activity of cyclodextrin-encapsulated propolis	2018	30	[40]
36	HS Ching, N Luddin, TP Kannan…	Modification of glass ionomer cements on their physical-mechanical and antimicrobial properties	2018	29	[41]
37	A Raza, U Hayat, M Bilal, HMN Iqbal…	Zein-based micro-and nano-constructs and biologically therapeutic cues with multi-functionalities for oral drug delivery systems	2020	28	[42]
38	SM Azab, AM Fekry	The application of a bee glue-modified sensor in daclatasvir dual effect detection	2017	19	[43]
39	Y Shahbazi, N Shavisi	A novel active food packaging film for shelf-life extension of minced beef meat	2018	19	[44]
40	T Khare, SS Palakurthi, BM Shah, S Palakurthi…	Natural product-based nanomedicine in treatment of inflammatory bowel disease	2020	19	[45]
41	CC Carrion, M Nasrollahzadeh, M Sajjadi…	Lignin, lipid, protein, hyaluronic acid, starch, cellulose, gum, pectin, alginate and chitosan-based nanomaterials for cancer nanotherapy: Challenges and opportunities	2021	19	[46]

42	K Villalobos, H Rojas, R González-Paz…	Production of starch films using propolis nanoparticles as novel bioplasticizer	2017	18	[47]
43	E Adomavičiūtė, J Baltušnikaitė-Guzaitienė…	Formation and characterization of melt-spun polypropylene fibers with propolis for medical applications	2018	18	[48]
44	T Sato, D Mello, L Vasconcellos, AJM Valente…	Chitosan-based coacervate polymers for propolis encapsulation: Release and cytotoxicity studies	2020	18	[49]
45	S Patil, N Desai, K Mahadik, A Paradkar	Can green synthesized propolis loaded silver nanoparticulate gel enhance wound healing caused by burns?	2015	17	[50]
46	S Ceylan	Propolis loaded and genipin-crosslinked PVA/chitosan membranes	2021	17	[51]
47	S El-Guendouz, B Lyoussi, JP Lourenço…	Magnetite nanoparticles functionalized with propolis against methicillin resistant strains of Staphylococcus aureus	2019	16	[52]
48	F Zeighampour, F Alihosseini…	Comparison of prolonged antibacterial activity and release profile of propolis-incorporated PVA nanofibrous mat, microfibrous mat, and film	2018	16	[53]
49	D Fasolo, B Pippi, G Meirelles, G Zorzi…	Topical delivery of antifungal Brazilian red propolis benzophenones-rich extract by means of cationic lipid nanoemulsions optimized by means of Box-Behnken …	2020	16	[54]
50	AA Elgendy, DM Fayyad	Cell viability and apoptotic changes of dental pulp stem cells treated with propolis, chitosan, and their nano counterparts	2017	13	[55]

3.2. Development and research in the field of nano propolis

The development of research in the field of propolis nanoparticles published in google scholar indexed journals is shown in **Table 2**. Based on the data presented, it can be seen that the number of studies on the topic of propolis nanoparticles is 1000 articles from 2012-2021. During 2012 there were 9 articles published. In 2013 there were 10 articles. In 2014 there were 25 articles. In 2015 there were 26 articles. In 2016 there were 42 articles. In 2017 there were 63 articles. In 2018 there were 81 articles. In 2019 there were 119 articles. In 2020 there were 171 articles. In 2021 there were 248 articles and as of September 2022 there have been 195 published articles. **Figure 1** shows the development of propolis nanoparticle research over the last 10 years in the 2012-2022 range. Based on **Figure 1** the number of publications on nano propolis has increased steadily, these data indicate that the popularity of research in the field of propolis nanoparticles tends to increase.

Table 2. Data on the number of publications of propolis nanoparticles

Year	Number of publications
2012	9
2013	10
2014	25
2015	26
2016	42
2017	63
2018	81
2019	119
2020	171
2021	248
2022	195
Total	989
Average	89,91

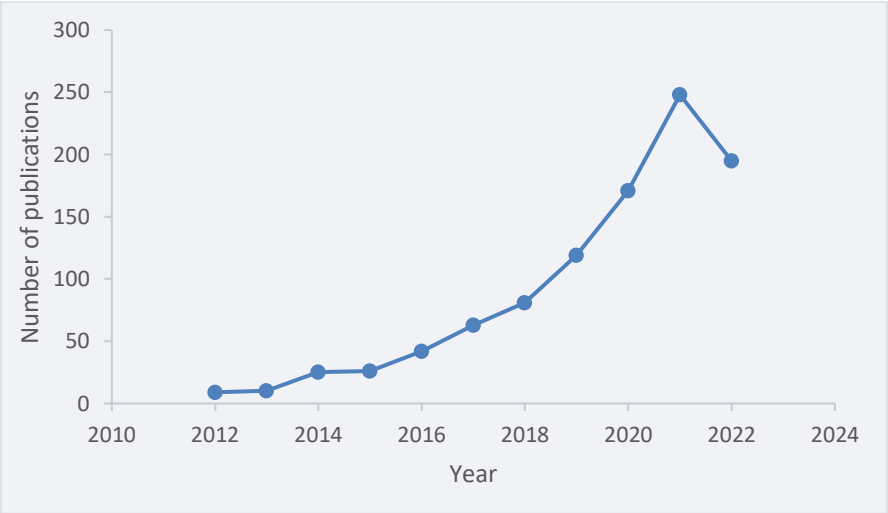

Figure 1. Graph of the number of studies in the field of propolis nanoparticles

3.3. Visualization nano propolis topic area using VOSviewer

For computational mapping carried out on article data, VOSviewer is used. From the computational mapping data available in **Figure 2**, 201 items were found. Each item found related to propolis nanoparticles in the data is divided into 8 clusters, namely:

a) Cluster 1 has 33 items marked in red, the 33 items are ability, anticancer activity, beeswax, bioavailability, biocompatibility, carrier, cell, characterization, chemical composition, controlled release, cycolodextrin, cytotoxicity, data, drug, drug delivery system, efficiency, formulation, lipid nanoparticle, liposome, malvern, nano carrier, nanoparticle size, nanostructured lipid carrier, niosome, oil, optimazion, paper, polymeric nanoparticle, propolis wax, solid lipid nanoparticle, solubility, stability, zeta potential.

b) Cluster 2 has 31 items marked in green, the 31 items are antibacterial property, aqueous solution, caffeic acid, case, chrysin, compound, drug delivery, effect, electrode, stimulation, ethanol, honey, incorporation, laccase, magnetic nanoparticle, magnetite nanoparticle, matrix, mechanical property, nano formulation, parameter, particle, phenolic compound, preparation, process, propolis, simultaneous determination, solution, structure, technique, total flavonoid content, vitro evaluation.
c) Cluster 3 has 28 items marked in blue, the 28 items are antibacterial effect, antimicrobial activity, antimicrobial effect, antimicrobial efficacy, antimicrobial property, assessment, brazilian red propolis, chitosan nanoparticle, chlorhexidine, combination, comparative study, dentisty, enterococcus faecali , evaluation, gel, intracanal medicament, miswak, nano chitosan, nano propoli, nano silver, nano size, propoli, propolis nanoparticle, silver nanoparticle, sodium hypochlorite, mutant streptococcus, vitro study.
d) Cluster 4 has 28 items marked in yellow, the 28 items are antibiotic, antioxidant activity, cellulose, comprehensive review, curcumin, dimension, electrospun nanofiber, encapsulation, food, healing, influence, liver, mechanism, medical application, membrane, nano emulsion, nanofiber, poly, recent advance, research, strach, vinyl alchol, vitro, vivo study, wound, wound dressing, wound healing, wound healing application.
e) Cluster 5 has 27 items marked in purple, the 27 items are activity, addition, application, bacterial cellulose, bee, bone tissue engineering, caffeic acid phenethyl ester, cancer cell, CAPE, efficiency, enhancement, flavonoid, morphology, nano, nanoemulsion, nanotechnology, oxideative stress, PLGA nanoparticle, polymer, production, propolis extract, protective effect, quercetin, skin, temperature, toxicity, water.
f) Cluster 6 has 22 items marked with sky blue, the 22 items are aggregation, agriculture, analysis, antifungal activity, AUNP, biomedical application, characterization, concentration, copper nanoparticle, flavonid content, gold nanoparticle, green synthesis, growth, nanocomposite, nanoparticle, perspective, plant, potential application, presence, reduction, synthesis, synthesized nanoparticle.
g) Cluster 7 has 20 items marked in orange, the 20 items are active packaging, biological activity, biopolymer, bosynthesis, cellulse nanoparticle, chemical, coating, essential oil, extract, film, food packaging application, microbe, preservation, protein, rainbow trout, shelf life, storage, surface, surface charge, type.
h) Cluster 8 has 12 items marked with brown color, the 12 items are Ag nanoparticle, antibacterial activity, anticancer, biological application, development, fabrication, lycopene, medicine, metallic nanoparticle, nanoencapsulation, natural product, plan extract.

The relationship between one term and another is shown in each existing cluster. A label is given to each term with a different colored circle for each cluster. The frequency with which the term occurs affects the size of the circle. The larger the circle, the more frequently the term is found. The mapping visualization analyzed in this study consists of 3 parts: Network visualization (see **Figure 2**), Density visualization (see **Figure 3**), and Overlay visualization (see **Figure 4**).

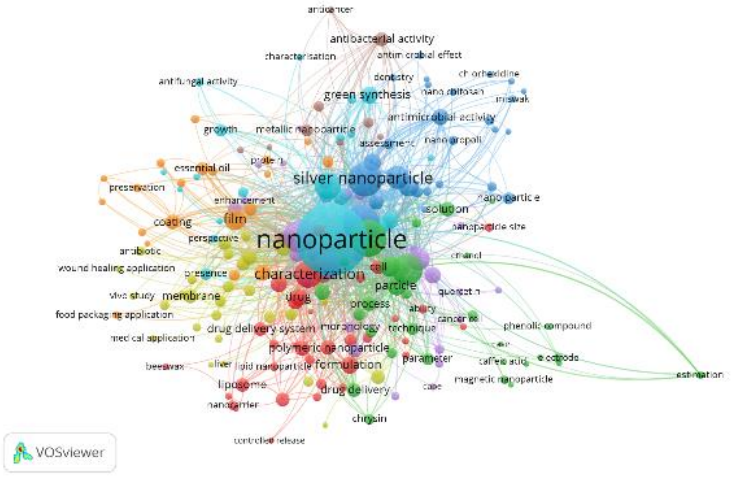

Figure 2. Network visualization for keywords nano propolis and nanoparticles

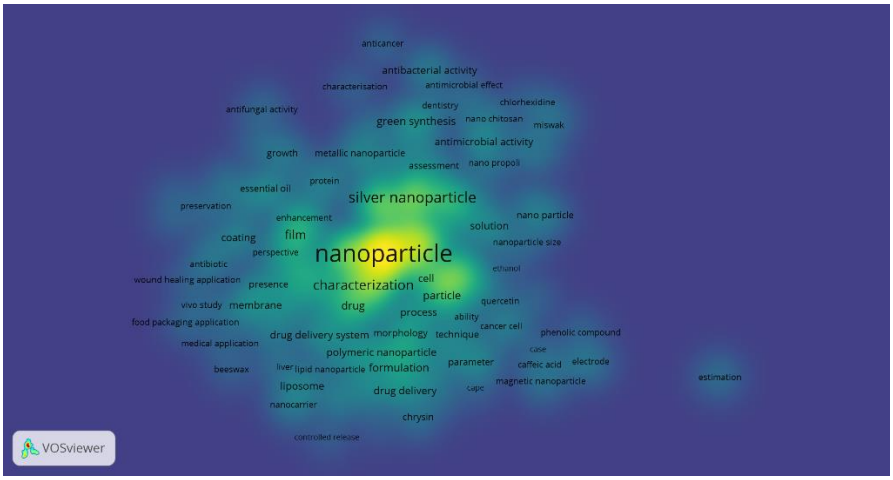

Figure 3. Density visualization for keywords nano propolis and nanoparticles

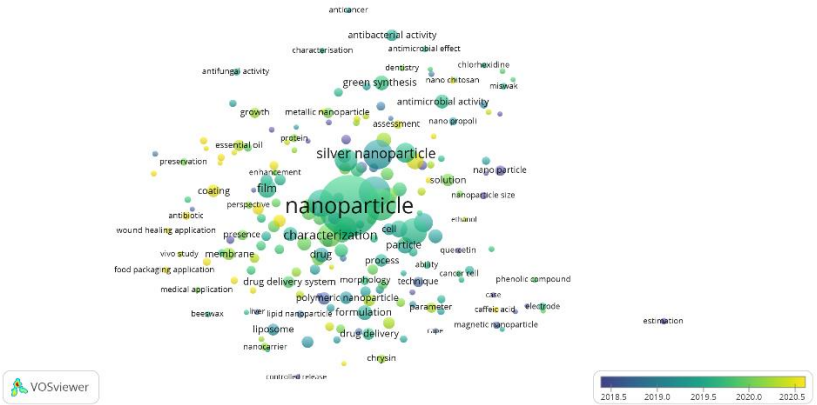

Figure 4. Overlay visualization for keywords nano propolis and nanoparticles

Figure 2 shows the relationship between the terms. The clusters on each of the terms in **Figure 2** show terms that are often studied in the topic of nano propolis. From the clusters contained in the network visualization, it can be seen that research on nano propolis is divided into 3 main fields, namely nanoparticles, propoli, and propolis. In the nanoparticle cluster belonging to cluster 6 with a total of 199

links, 2408 total link strength, and 646 occurrences (see **Figure 5**). Next for the term propoly which is included in cluster 3 with a total of 172 links, 795 total strength, and 169 occurrences (see **Figure 6**). Lastly, propolis belonging to cluster 2 has 151 links, 558 total link strength, and 120 occurrences (see **Figure 7**).

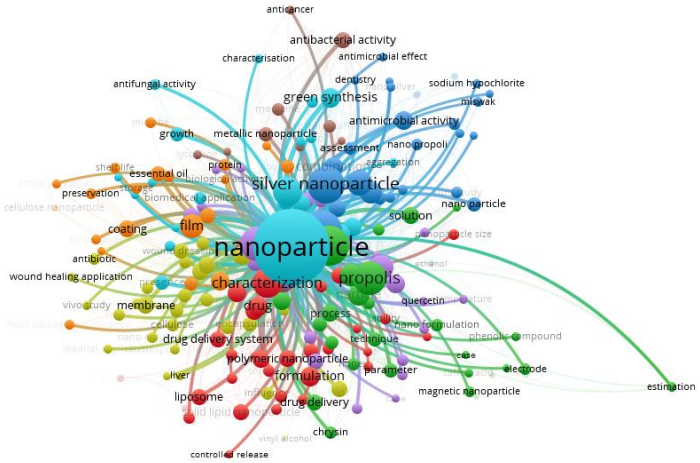

Figure 5. Network visualization of nanoparticle term

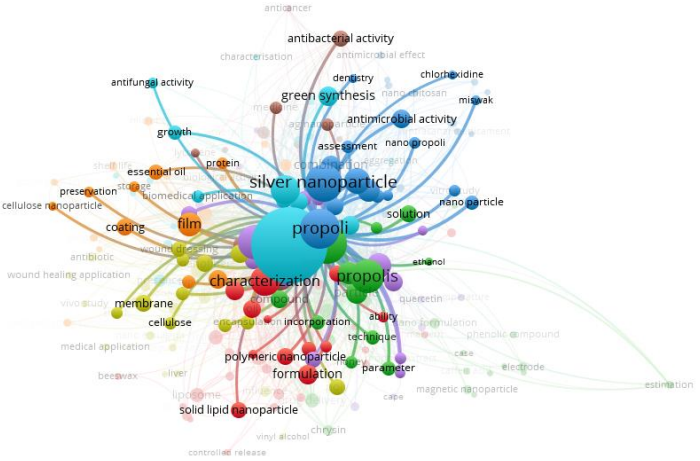

Figure 6. Network visualization of propoli term

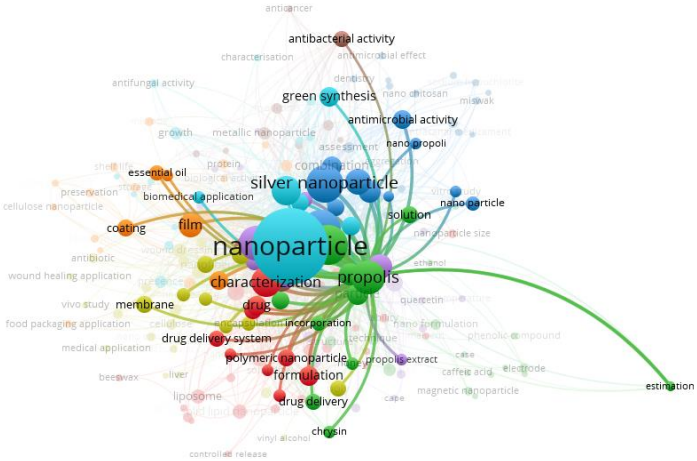

Figure 7. Network visualization of propolis term

Figure 3 shows the density visualization. In this visualization, the terms that appear most often will show a bright yellow color and the diameter of the circle of term labels will be large. This shows that research on this topic is being carried out a lot. Based on Figure 3, it can be seen that the topic of nanoparticles, propolis, films, silver nanoparticles has a yellow color indicating that the term has a high number of studies.

Figure 4 shows overlay visualization in nanopropolis research. The color difference in the circles indicates the novelty of research on related terms. It shows that research on propolis began in 2020 until now. The term nanopropolis has begun to be studied in research in 2019. For nanoparticles in 2018 many studies have been carried out. With this it can be assumed that new research on nanopropolis can be carried out.

Figure 5 shows a network visualization of nanoparticles related to other terms such as propolis, nanopropoli, silver nanoparticle, film, characterization, drug, metallic nanopartcle, essential oil, antifungal activity, green synthesis, density, antimicrobial effect, sodium hypochlorite, miswak, solution, quercetin, electrode, magnetic nanoparticle, case, technique, parameter, ability, process, polymeric nanoparticle, drug dekivery system, liver, membrane, healing application, antibiotic, growth, liposome, and antimicrobal activity. Figure 6 shows a network visualization of propoli related to propolis, nano particle, nano propoly, miswak, chlorhexidine, assessment, silvernanoparticle, solution, ability, densitry, green synthesis, anti-tubacretial activity, antimicrobal activity, protrin, growth, antifungal activity, essential oil , preservation, nanoparticle, coating, film, membrane, cellulose, solid lipid nanoparticle, polymeric nanoparticle, characterization, and parameters. Figure 7 shows a network visualization of propolis related to other terms such as nanoparticle, solution, propolis extract, polumeric nanoparticle, drug delivery, chyrsin, formulation, drug, drug delivery system, film, characterixzation, coating, essential oil, biomedical application, membrane, green synthesis, antibacterial activity, antimicrobial activity, nano propoly, silver nanoparticles, and estimation. Based on network visualization data, propolis has 151 links and is connected with 21 terms, this number is less than the nanoparticle and propoli fields which have a higher level of relevance. So it can be concluded that the field of study for propolis is still very possible to be researched and associated with other terms, of course this will make research have a high impact on novelty in the field of nanoparticle studies.

From the data collected, it can be seen that the keywords for propolis in the nanoparticle field are still rarely used in research, this can be seen from the mapping of the article data. So the study of nano propolis or nano particle propolis can be an option if we are looking for a newer or up to date field of study

4. Conclusion

This research was conducted for computational mapping of bibliometric analysis of published data in the field of nano propolis. The data used in this study came from articles indexed on Google Scholar and filtered using Publish or Perish software. So it was found 1000 articles related to nanoparticles and nano propolis in the range of 2012-2022. Based on mapping visualization using VOSviewer software, it shows an increase in research interest on nano propolis in 2019-2020. As the result it can be concluded that the research topic in the field of nano propolis can be an option by researchers to be further developed.

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