Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Antioxidant Activity of Gel Formulations Containing Various Plant Leaf Extracts: A Review

Diva Valentin*, Devi Ratnasari, Ailla Az-zahraa, Theresia Natalie Cahyani, Tasya Permata Shella, Muhammad Adit Adzkia

Department of Pharmacy, Faculty of Health Sciences, Singaperbangsa Karawang University, Karawang, Indonesia
*e-mail: devi.ratnasari@fkes.unsika.ac.id

Received: December 27, 2024. Accepted: January 29, 2025. Published: January 30, 2025

Abstract: Antioxidants protect the skin from the adverse effects of free radicals, which can potentially trigger premature aging and even skin cancer. Free radicals, with unpaired electrons, are highly reactive and can damage cellular structures. However, the high risk of side effects from synthetic antioxidants, such as skin cancer, has increased interest in natural sources. In cosmetic formulations, gel preparations are highly favored because they can optimally and stably deliver active ingredients to the skin. This study employed a literature review method by examining and collecting articles from relevant scientific journals published over the past 10 years (2014–2024), with 13 articles as primary references. The analysis found that several extracts, such as *leilem* leaf, pandan, and green tea, exhibited strong antioxidant potential, as indicated by low IC50 values, making them ideal as active ingredients in gel formulations. In addition to the type of plant leaves, the effectiveness of these antioxidants is influenced by the extract concentration used, solvent selection during extraction, and the processing techniques employed in formulation.

Keywords: Antioxidant; Gel; Plant Leaf Extract.

Introduction

Antioxidants have become highly intriguing compounds for cosmetics and pharmaceuticals due to their significant role in protecting the skin from the detrimental effects of free radicals. Free radicals are molecules with unpaired electrons in their outer orbitals. These molecules continuously seek stability by attacking cellular components such as lipids, lipoproteins, proteins, carbohydrates, RNA, and DNA [1]. Excessive exposure to ultraviolet radiation can generate free radicals, leading to skin damage. This damage has the potential to cause various health issues, including premature aging, skin deterioration, and even skin cancer [2].

Excessive ultraviolet (UV) radiation exposure generates free radicals that can damage skin, highlighting the need for antioxidants to protect the skin. Antioxidant compounds are sufficiently stable to donate electrons or hydrogen atoms to free radicals, thereby neutralizing them and reducing their potential to trigger chain reactions, triggering free radical formation [3]. In counteracting free radicals, antioxidants inhibit the initiation and propagation phases of chain oxidation reactions by converting free radicals into non-reactive compounds [4].

Antioxidants come in various types and can be classified based on their origin into synthetic and natural antioxidants. Common synthetic antioxidants in cosmetic products include BHA, BHT, TBHQ, propyl gallate, dioxybenzone, EDTA, and hexylresorcinol [5]. Synthetic antioxidants in cosmetic formulations are limited due to potential side effects and evidence suggesting that synthetic antioxidants may promote cancer cell growth in mice [6]. This has led to increasing interest in replacing synthetic antioxidants with natural ones. Natural antioxidants can be found in various parts of plants, such as stems, bark, leaves, flowers, and roots [7]. One of them is the leaves, which are part of the herbal plant that can be used as a source of antioxidants. A part of the leaves of herbal plants has compounds that have the potential to fight free radicals, such as flavonoids, carotene, catechins, resveratrol, vitamins C and E [8].

The high content of antioxidant compounds in plant leaves has led to the significant use of plant leaf extracts as antioxidant products. These products can be formulated into cosmetic preparations such as gels, creams, ointments, lotions, and powders [9]. Cosmetics are formulations designed to be applied to the external surface of the human body, such as the skin, nails, hair, lips, teeth, and mucous membranes [10]. Using natural antioxidant active ingredients in topical cosmetic formulations for skincare can help protect the skin from various skin issues. Antioxidants have the potential to slow down signs of aging, prevent skin inflammation, and stimulate collagen production for the skin. [11].

A practical and comfortable cosmetic formulation is needed to slow down and address skin damage caused by the adverse effects of free radicals. In the cosmetic industry, gel formulations are one of the preferred choices. A gel is a semi-solid substance consisting of a dispersion formed from either small inorganic particles or large organic particles interspersed with a liquid [12]. Gel formulations are often chosen because they offer numerous advantages, such as good spreading ability on the skin surface, optimal release of active ingredients, and a clear, elegant appearance. When

How to Cite:
D. Valentin, D. Ratnasari, A. Az-zahraa, T. N. Cahyani, T. P. Shella, and M. A. Adzkia, "Antioxidant Activity of Gel Formulations Containing Various Plant Leaf Extracts: A Review", *J. Pijar.MIPA*, vol. 20, no. 1, pp. 141–147, Jan. 2025.
https://doi.org/10.29303/jpm.v20i1.8288

applied, the gel forms a transparent layer, is easy to remove, and has good stability during storage [13].

This literature review aims to examine the antioxidant activity in gel formulations containing plant leaf extracts, provide recommendations for the best natural antioxidant ingredients for gel-based cosmetic products, and explore various aspects influencing their effectiveness. Consequently, this review study can serve as a solution to address skin health issues, such as damage and premature aging caused by free radicals, by developing practical, convenient, and effective gel-based cosmetic products.

Research Methods

The method employed to collect the data used for this review is a literature review article. This process involves searching and gathering articles from various previously published scientific journals. The literature search process follows the guidelines of the Preferred Reporting Items for Systematic Review and Meta-Analyzes (PRISMA). The keywords for searching journals on the site are Antioxidant, Gel Preparation, and Plant Leaf Extract. After the articles are found, they are analyzed and synthesized according to inclusion criteria. The inclusion criteria are: (1) Gel preparations containing plant leaf extracts, (2) Gel preparations tested for antioxidant activity using the DPPH method, and (3) Containing a single plant type. The Population, Intervention, Control, and Outcome (PICO) framework is used to establish the inclusion criteria for this study. Table 1 presents the PICO framework applied in this research. The obtained articles are selected to determine their relevance to the desired topic. After identifying the relevant articles, they are analyzed to get the results.

Results and Discussion

The review results indicate that gel formulations with various plant leaf extracts fall into several categories. Antioxidant compounds are classified as powerful antioxidants if the IC50 value is small or less than 50, strong (50-100), moderate (100-150), and weak (151-200). Antioxidant activity increases as the IC50 value decreases [26]. Gel formulations with vigorous antioxidant activity at low concentrations include extracts from fragrant pandan leaves (*Pandanus amaryllifolius Roxb*) and *leilem* leaves (*Clerodendrum minahassae Teisjm and Binn*.). Meanwhile, vigorous antioxidant activity with a high concentration (10%) is found in green tea leaf extract (*Camellia sinensis*). The gels with vigorous antioxidant activity at low concentrations include extracts from robusta coffee leaves (*Coffea canephora*) and *juwet* leaves (*Syzygium cumini L*.). Vigorous antioxidant activity with high concentrations is found in mulberry leaves (*Morus alba L*.), starfruit leaves (*Averrhoa bilimbi L*.), and breadfruit leaves (*Artocarpus altilis*). Moderate antioxidant activity in gel formulations with extracts is observed in *sesewanua* leaves (*Clerodendrum squamatum Vahl*) and pacing leaves (*Cheilocostus speciosus*). Additionally, very weak antioxidant activity is found in cherry leaves (*Antidesma bunius L. Spreng*) and *bidara* leaves (*Ziziphus mauritiana Lamk*).

Table 1. PICO Framework

P (Population)	Gel formulation containing plant leaf extract
I (Intervention)	Testing antioxidant activity in gel formulations containing plant leaf extract.
C (Comparison)	Comparison between various plant leaf extracts.
O (Outcome)	Antioxidant activity produced by plant leaf extracts in gel formulations.

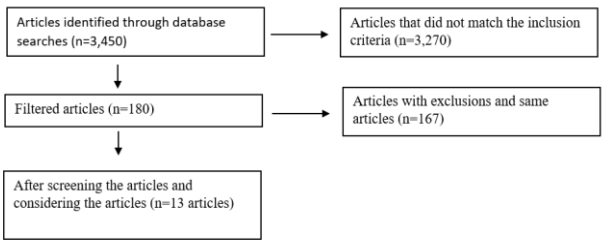

Figure 1. Article search flow process

Table 2. Antioxidant activity value of plant leaf extract in gel formulation

Plant leaf names	Extraction methods	Extract concentration (%)	IC50 (ppm)	Gelling agent	category
Bidara leaf (*Ziziphus mauritiana Lamk)* [14]	Maceration	6%	998.736	Carbopol	Sangat lemah
Fragrant pandan leaf (*Pandanus amaryllifolius Roxb.)* [15]	Maceration	1%-3%	46.6090-30.5659	Carbomer	Very strong
Murbei leaf (*Morus alba L)*	Maceration	5%-9%	74.955-57.122	Carbopol	Strong
Moringa leaf *(Moringa oleifera Lam)* [16]	Maceration	3%	97.484	Carbomer	Strong
Starfruit leaf *(Averrhoa bilimbi L.)* [17]	Maceration	10%-15%	94.16-89.12	HPMC	Strong

Leilem leaf *(Clerodendrum minahassae teisjm dan binn.)* [18]	Maceration	5%	43.40	HPMC	Very Strong
Sesewanua leaf *(Clerodendron squamatum Vahl)* [19]	Maceration	5%	123	HPMC	Medium
Breadfruit leaves *(Artocarpus altilis)* [20]	Maceration	20%	66.96	Carbopol	Strong
Pacing leaves *(Cheilocostus speciosus)* [21]	Maceration	1.2%	139.074	HPMC	Medium
Daun Juwet *(Syzygium cumini L)* [22]	Maceration	4%	94.44	Carbopol	Strong
Green tea leaves *(Camellia sinensis)* [23]	Infusion Method	10%	47.316	HPMC	Very strong
Cherry Leaves (*Antidesma bunius L. Spreng*) [24]	Maceration	3.65%	6238.41	HPMC	Very weak
Robusta coffee leaves (*Coffea canephora*) [25]	Maceration	0.5%	65.58	HPMC	Strong

In gel formulations containing fragrant pandan leaf extract (*Pandanus amaryllifolius Roxb*), the antioxidant activity ranged from 46.6090 to 30.5659, with concentrations between 1% and 3%. This finding aligns with previous studies reporting that fragrant pandan leaf extract exhibits vigorous antioxidant activity, as indicated by an IC50 value of 41.544 ± 1.415 ppm [27]. This consistency is attributed to flavonoids, tannins, and other phytochemical compounds in fragrant pandan leaves, contributing to their antioxidant activity.[28]. The extraction process was done through maceration using 70% ethanol as the solvent. This indicates that the polarity of the compounds in fragrant pandan leaves closely matches the polarity of the solvent, resulting in vigorous antioxidant activity. Seventy percent ethanol is an appropriate solvent for extracting flavonoid compounds due to its moderate polarity [29]. However, other studies have reported lower antioxidant activity in pandan wangi leaf extract due to differences in the type of solvent used. For example, research using other polar solvents, namely methanol, gave results that were included in the strong category, with an IC50 value of 86.861 ppm [30]. This difference is due to the characteristics of methanol, which does not contain water, in contrast to technical ethanol, which has a higher water content as an impurity. As a result, ethanol has a more dominant polar nature than methanol, so that it can dissolve flavonoid compounds in more significant quantities. Flavonoids, polar compounds, tend to be more easily extracted by polar solvents such as ethanol [31].

The gel formulation containing *Clerodendrum minahassae* (leilem) leaf extract exhibited an antioxidant activity value of 43.40 ppm with an extract concentration of 5%. The secondary metabolites found in *leilem* leaves include phenolic compounds, a type of polyphenol known for its potential as a free radical inhibitor [18]. The extraction process involved maceration using 96% ethanol as the solvent. This is due to the polar nature of phenolic compounds, which allows polar solvents like ethanol and water to dissolve them. Consequently, ethanol at a concentration of 96% has a polarity similar to that of phenolic compounds, making it practical for extracting these compounds [32].

The antioxidant activity of green tea (*Camellia sinensis*) leaf extract was measured at 47.316 ppm. Green tea contains polyphenolic compounds with powerful antioxidant potential. One type of polyphenol, flavonoids, represents the largest polyphenols and is highly effective as an antioxidant. The extraction method utilized was infusion, which involves boiling water to extract water-soluble active compounds from plant materials. Furthermore, the secondary metabolites in green tea are predominantly polar, making them readily soluble in polar solvents such as water [33].

The gel formulation containing robusta coffee (*Coffea canephora*) leaf extract demonstrated an antioxidant activity value of 65.58 ppm, categorized as strong. Robusta coffee leaves contain flavonoid compounds with significant antioxidant potential. The intense antioxidant activity of robusta coffee leaves highlights their potential for development as a topical preparation. The extraction technique employed was maceration using 96% ethanol as the solvent. Flavonoid compounds are polar, which allows them to dissolve effectively in polar solvents like 96% ethanol [34].

The gel formulation containing *Syzygium cumini* L. (juwet) leaf extract exhibited an antioxidant activity value of 94.44 ppm, categorized as strong. Phytochemical screening revealed that *juwet* leaf extracts in water, methanol, and ethanol contain flavonoids, tannins, and polyphenols [22]. This indicates that *Syzygium cumini* leaf extract has the potential to serve as a natural ingredient with antioxidant activity capable of neutralizing free radicals [35]. The extraction technique employed was maceration using 70% ethanol as the solvent. This solvent is suitable for the extraction method because flavonoid compounds are typically polar glycosides, requiring a solvent with similar properties for dissolution, and 70% ethanol is an effective polar solvent [36].

The gel formulation containing *Morus alba* L. (mulberry) leaf extract exhibited antioxidant activity values ranging from 74.955 to 56.122 ppm, with 5% and 9% extract concentrations. These results indicate that the Morus

alba leaf extract gel formulation has intense antioxidant activity. The active metabolites responsible for the antioxidant properties in the ethanol extract of mulberry leaves include alkaloids, flavonoids, tannins, saponins, steroids, and terpenoids [37]. The extraction method employed was maceration using 70% ethanol as the solvent. The 70% ethanol solvent is effective in extracting flavonoid compounds. The presence of sugars attached to flavonoids (known as flavonoid glycosides) allows the flavonoids to dissolve in water. Therefore, 70% ethanol is an effective solvent for extracting flavonoid compounds [38]. The gelling agent used in this gel formulation is carbopol, a gel-forming agent due to its high stability, resistance to microbes, and widespread application in pharmaceutical and cosmetic fields[39].

The gel formulation containing bilimbi leaf extract (*Averrhoa bilimbi L.*) exhibited antioxidant activity within the 94.16–89.12 ppm range, with extract concentrations ranging from 10% to 15%. This gel formulation falls under the category of vigorous antioxidant activity. The bilimbi leaves were extracted using the maceration process with 70% ethanol as the solvent. Phytochemical screening confirmed the extract's presence of flavonoids, alkaloids, saponins, tannins, glycosides, and terpenoids [40]. Flavonoids possess antioxidant capabilities, including neutralizing free radicals [41]. The extraction process used maceration with 70% ethanol as the solvent. This solvent is highly efficient in extracting metabolites such as flavonoids, as sugar bonds in flavonoids enhance their solubility in water, making it an effective solvent for flavonoid extraction [38]. The gelling agent used was HPMC, chosen for its clear gel appearance, compatibility with other ingredients, and excellent capability as a hydrogel-forming agent [42].

In the gel preparation containing breadfruit leaf extract (*Artocarpus altilis*), an antioxidant activity value of 66.96 ppm was obtained at a concentration of 20%. This indicates that the gel preparation falls into the strong antioxidant category. Phytochemical screening of breadfruit leaves revealed the presence of various compounds, including saponins, tannins, flavonoids, polyphenols, hydrocyanic acid, acetylcholine, and riboflavin. Flavonoids in breadfruit leaves act as natural antioxidants, playing a role in neutralizing free radicals, protecting cells from damage, and preventing disease onset [43]. The high efficiency of 96% ethanol in extracting bioactive compounds surpasses that of other solvents. This indicates that most bioactive compounds in breadfruit leaves are soluble in polar solvents. The active compounds dissolve in ethanol due to their polarity, and the solvent's volatility facilitates the release of these compounds from the extract [34].

In the gel preparation containing *sesewanua* leaf extract (*Clerodendron squamatum Vahl*), an antioxidant activity value of 123 ppm was obtained at a concentration of 5%. This indicates that the gel preparation of *sesewanua* leaf extract falls into the moderate antioxidant category. The metabolites present in *sesewanua* leaves include alkaloids and flavonoids, which have potential as antioxidants. Previous studies reported that the antioxidant value of *sesewanua* leaf extract was 17.85 ppm, which falls into the firm category. This result contrasts the antioxidant activity value obtained from the sesewanua leaf extract's gel preparation [44]. This discrepancy may be attributed to sample preparation processes and gel formulation, which can affect antioxidant activity. Inappropriate handling may increase environmental exposure, risking a reduction in antioxidant activity in the formulation [19].

In the gel formulation containing *pacing* leaf extract (*Cheilocostus speciosus*), an antioxidant activity value of 139.074 ppm was obtained, which falls into the moderate category. Phytochemical analysis revealed that *pacing* leaves contain flavonoids, saponins, anthraquinones, terpenoids, steroids, and anthraquinones. Previous studies have evaluated the antioxidant activity of *pacing* plants, with results indicating an IC50 value of 17.8 ppm, placing it in the firm category [45]. This result contrasts with the antioxidant value observed in the gel preparation of *pacing* leaf extract. The minor concentration used in the gel formulation, which is 1.2%, may have influenced its antioxidant activity, as lower concentrations generally result in lower antioxidant activity.

The gel formulation containing *Ceri* leaf extract (*Antidesma bunius* L. Spreng) obtained an antioxidant activity value of 6238.41 ppm, which falls into the very weak category. Previous research has reported that ethanol extract from the leaves has strong antioxidant potential, with an IC50 value of 61.8 ppm [46]. This result contrasts with the antioxidant value observed in the gel formulation of *Ceri* leaf extract. This discrepancy may be influenced by the solvent used during the extraction process, as 96% ethanol was utilized, which can affect the solubility of flavonoids. The higher the ethanol concentration, the lower the polarity of the solvent [47]. Another factor is the very low concentration in the gel formulation, which was only 3.56%, which reduced antioxidant activity.

The gel formulation containing *Bidara* leaf extract (*Ziziphus mauritiana* Lamk) obtained an antioxidant activity value of 998.736 ppm, placing it in the weak antioxidant category. Antioxidant activity is considered weak if the IC50 value exceeds 500 ppm. *Bidara* leaf extract contains phenolic compounds, including flavonoids, alkaloids, and tannins, exhibiting antioxidant potential through electron donation or halting free radical reactions. The 70% ethanol extract of *Bidara* leaves demonstrated intense antioxidant activity, with an IC50 value of 4.9379 ppm, indicating vigorous antioxidant activity. This result contrasts with the antioxidant value observed in the gel formulation of *Bidara* leaf extract. The decrease in antioxidant activity is attributed to the suboptimal delivery of active compounds from the gel base during the reaction with DPPH in the assay. Furthermore, heating during the gel preparation could reduce the active compound content [48].

Achieving optimal antioxidant effectiveness is influenced by the type of leaves used and other factors, such as the concentration of the plant leaf extract. Higher extract concentrations generally result in more excellent antioxidant activity. Furthermore, the choice of solvent in the extraction method plays a critical role in determining the types of active compounds extracted. Polar compounds are more likely to be extracted using polar solvents, while non-polar compounds are better extracted with non-polar solvents [14]. Examples of polar solvents include ethanol, methanol, acetone, and water. Additionally, improper handling during sample preparation, gel formulation, and

antioxidant activity testing can affect the effectiveness of antioxidants. Such suboptimal processes can lead to a decrease in antioxidant activity in the final formulation.

Conclusion

Based on the literature review of 13 journals, various types of plant leaves show potential as active ingredients in gel formulations with antioxidant activity. Each plant leaf formulated in gel form exhibits varying IC50 values, ranging from very weak to powerful antioxidant potential. Leaf extracts such as leilem, fragrant pandan, and green tea have demonstrated potent antioxidant activity, making them among the most suitable candidates for gel-based cosmetic applications. To achieve optimal antioxidant effectiveness, the type of leaf and other factors, such as the concentration of the extract, solvent selection during the extraction process, and handling during formulation, need to be considered. This finding highlights that gels containing plant leaf extracts with antioxidant activity can potentially address skin health issues, such as damage and premature aging caused by free radicals.

Author's Contribution

Diva Valentin & Devi Ratnasari: provided guidance and supervision throughout the research process for this review article. She also offered valuable feedback and revisions to ensure the quality and accuracy of the manuscript. Ailla Az-zahraa, Theresia Natalie Cahyani, Tasya Permata Shella and Muhammad Adit Adzkia: contributed to the search and selection of sample data used in this review article.

Acknowledgements

We sincerely thank Mrs. Devi Ratnasari for her invaluable support and guidance throughout this research. Special thanks to Ailla Az-zahraa, Theresia Natalie Cahyani, Tasya Permata Shella, and Muhammad Adit Adzkia for their technical assistance and helpful suggestions.

References

[1] Y. Kesuma, *Antioksidan Alami dan Sintetik*. Padang: Andalas University Press. 2015.

[2] E. Fitraneti, Y. Rizal, S. Riska, I. Primawati, & D. Hamama, "Pengaruh Paparan Sinar Ultraviolet terhadap Kesehatan Kulit dan Upaya Pencegahannya : Tinjauan Literatur," *Scientific Journal*, vol. 3, no. 3, pp. 185–194, 2024, doi: https://doi.org/10.56260/sciena.v3i3.147

[3] M. Ibroham, S. Jamilatun, &D. K. Ika, "A Review: Potensi Tumbuhan-Tumbuhan Di Indonesia Sebagai Antioksidan Alami," in *Seminar Nasional Penelitian LPPM UMJ*, 2022, pp. 1–13.

[4] Rustaman, R. Satria, Janitra *et al*, "Studi Potensi Senyawa Antioksidan dari Kulit Jeruk Nipis (*Citrus Aurantifolia*) secara in Silico," *Chimica et Natura Acta*, vol. 11, no. 3, pp. 136–142, 2023.

[5] M. Stoia & S. Oancea, "Low-Molecular-Weight Synthetic Antioxidants: Classification, Pharmacological Profile, Effectiveness and Trends," *Antioxidants*, vol. 11, no. 4, 2022, doi: https://doi.org/10.3390/antiox11040638

[6] N. Nusaibah, C. I. Cempaka, S. Abrian, O. Susanti, & T. R. Andayani, "Karakteristik Face Scrub dari Sediaan Simplisia Rumput Laut *Sargassum sp*," *Majalah Farmasetika*, vol. 9, no. 1, p. 76, 2023, doi: https://doi.org/10.24198/mfarmasetika.v9i1.49265

[7] S. Saefudin, S. Marusin, & C. Chairul, "Aktivitas Antioksidan Pada Enam Jenis Tumbuhan *Sterculiaceae*," *Junal Penelitian Hasil Hutan*, vol. 31, no. 2, pp. 103–109, 2013, doi: https://doi.org/10.20886/jphh.2013.31.2.103-109

[8] A. Asrifaturofingah, E. Listiowati, F. U. Matsna, S. Z. Putriliana, &N. A. H. Ulya, "Analisis Aktivitas Senyawa Antioksidan Pada Berbagai Daun Tanaman Herbal dengan Metode DPPH," *Jurnal Pharmascience*, vol. 11, no. 1, p. 98, 2024, doi: https://doi.org/10.20527/jps.v11i1.16477

[9] I. Maya & Mutakin, "Review Artikel: Formulasi dan Evaluasi Secara Fisikokimia Sedian Krim Anti-Aging," *Farmaka*, vol. 17, no. 2, pp. 296–305, 2018.

[10] BPOM RI, "Peraturan Badan Pengawas Obat Dan Makanan Nomor 17 Tahun 2022 Tentang Perubahan Atas Peraturan Badan Pengawas Obat Dan Makanan Nomor 23 Tahun 2019 Tentang Persyaratan Teknis Bahan Kosmetika," *Bpom Ri*, pp. 1–338, 2022.

[11] A. Rizkyah & S. N. Karimah, "Literature Review : Penuaan Dini pada Kulit : Gejala , Faktor Penyebab dan Pencegahan," *Jurnal Gizi dan Kesehatan.*, vol. 3, no. 2, pp. 107–116, 2023, doi: https://doi.org/10.36086/jgk.v3i2.2029

[12] H. C. Ansel, *Pengantar sediaan farmasi*. Jakarta: Penerbit Universitas Indonesia, 1989.

[13] Y. Anggraeni, E. Hendradi, and T. Purwanti, "Karakteristik Sediaan Dan Pelepasan Natrium Diklofenak Dalam Sistem Niosom Dengan Basis Gel Carbomer 940," *PharmaScientia*, vol. 1, no. 1, pp. 1–15, 2012.

[14] W. Yulianti, G. Ayuningtyas, R. Martini, and I. Resmeiliana, "Pengaruh Metode Ekstraksi Dan Polaritas Pelarut Terhadap Kadar Fenolik Total Daun Kersen (*Muntingia calabura L*)," *Jurnala Sains Terapan.*, vol. 10, no. 2, pp. 41–49, 2020, doi: https://doi.org/10.29244/jstsv.10.2.41-49

[15] Liandhajani & H. N. Septiani, "Pengaruh Konsentrasi Ekstrak Dalam Sediaan Gel Terhadap Karakteristik, Stabilitas Fisik, Antioksidan Hedonik," *Jurnal Ilmiah Farmasi*, vol. 11, no. 1, pp. 75–84, 2022, doi: https://doi.org/10.30591/pjif.v11i1.2959

[16] U. Hasanah, Y. Yusriadi, and A. Khumaidi, "Formulasi Gel Ekstrak Etanol Daun Kelor (*Moringa oleifera Lam*) Sebagai Antioksidan," *Journal of Natural Science*, vol. 6, no. 1, pp. 46–57, 2017, doi: https://doi.org/10.22487/25411969.2017.v6.i1.8079

[17] M. Zaky, N. Rusdiana & A. Darmawati, "Formulasi Dan Evaluasi Fisik Sediaan Gell Antioksidan Ekstrak Etanol 70% Daun Belimbing Wuluh (*Averrhoa Bilimbi L*.) Menggunakan Metode Dpph" *Jurnal Farmagazine* vol. 7, no. 1, p. 278, 2021, doi: https://doi.org/10.47653/farm.v8i2.556

[18] E. R. Seru, H. J. Edy, & J. P. Siampa, "Formulation

Of Hpmc As Gelling Agent Gel Of Ethanol Extract Of Leilem Leaves (*Clerodendrum minahassae teisjm dan binn*) And Antioxidant Effectiveness Test Formulasi Hpmc Sebagai Gelling Agent Gel Ekstrak Etanol Daun Leilem (*Clerodendrum minahassae teis*," *Jurnal Pharmacon*, vol. 10, pp. 1033–1039, 2021.

[19] K. Runtuwene, P. V. Y. Yamlean, & A. Yudistira, "Formulasi,Uji Stabilitas Dan Uji Efektivitas Antioksidan Sediaan Gel Dari Ekstrak Etanol Daun Sesewanua (*Clerodendron squamatum Vahl*) Dengan Menggunakan Metode Dpph," *Pharmacon*, vol. 8, no. 2, p. 298, 2019, doi: https://doi.org/10.35799/pha.8.2019.29295

[20] S. A. Shofiah, "Forulasi, Karakteristik, Dan Uji Aktivitas Antioksidan Sediaan Gel Moisturizer Anti-Aging Ekstrak Daun Sukun (*Artocarpus altilis*)," *Indonesian Journal of Health Science*, vol. 4, no. 1, pp. 84–90, 2024, doi: https://doi.org/10.54957/ijhs.v4i1.579

[21] R. Sari, T.Elmitra. Nofiandi & D. Rezki, "Jurnal Katalisator," Formulasi Dan Uji Aktivitas Antioksidan Sediaan Gel Ekstrak Daun Pacing (*Cheilocostus speciosus*)" *Jurnal Katalisator* vol. 3, no. 2, pp. 135–144, 2018, doi: https://doi.org/10.22216/jk.v3i1.2297

[22] M. Elyadi, W. Subaidah, & Muliasari "Formulasi dan Uji Aktivitas Antiradikal Bebas Emulgel Ekstrak Daun Juwet (*Syzygium cumini L*.) dengan Metode DPPH (*Diphenilpycrylhydrazil*)," *Jurnal Sains dan Kesehatan.*, vol. 3, no. 1, pp. 242–247, 2021, doi: https://doi.org/10.25026/jsk.v3i3.565

[23] D. P. Sukamdi, A. Zahrah, S. Harimurti, V. L. Damarwati, R. Erviana, & A. Amid, "Optimization of Antioxidant Gel Formula Green Tea Leaf Extract (Camellia sinensis L.) With Virgin Coconut Oil (VCO)," in *Proceedings of Selected Papers of International Conference on Health, Science, and Environment.* pp. 122–130. 2024, doi: https://doi.org/10.2991/978-94-6463-431-0_14

[24] W. A. Subaidah, Y. Andayani, & D. A. P. Kumaradewi, "Emulgel formulation of wild cherry leaves (*Antidesma bunius L. Spreng*) extract and its antioxidant activity," *Acta Pharm. Indones. A Acta Pharmaciae Indonesia*, vol. 10, no. 2, p. 4036, 2022. doi: https://doi.org/10.20884/1.api.2022.10.2.4036

[25] D. P. Wijaya, H. Herlina, & R. Astryani, "Formulasi Dan Uji Antioksidan Gel Ekstrak Daun Kopi Robusta *(Coffea canephora*)," *Jurnal Ilmiah Farmako Bahari*, vol. 12, no. 2, p. 141, 2021, doi: https://doi.org/10.52434/jfb.v12i2.1106

[26] A. V Badarinath *et al.*, "A Review On In-Vitro Antioxidant Methods: Comparisions, Correlations and Considerations," *International Journal of PharmTech Research*, vol. 2, no. 2, pp. 1276–1285, 2010.

[27] M. Ulfah, F. Sethyana & S.A.F, Anam "Potensi Antioksidan dan Kadar Total Fenolik Flavonoid Ekstrak Daun Pandan Wangi (*Pandanus Amarillyfolius Roxb*.) pada Variasi Pelarut," *Media Farmasi Indonesia.*, vol. 18, no. 2, pp. 115–123, 2023, doi: https://doi.org/10.53359/mfi.v18i2.227

[28] Rahmasiahi, S. Hadiq, & T. Yulianti, "Skrining Fitokimia Ekstrak Metanol Daun Pandan (*Pandanus amarillyfolius* Roxb)," *Journal of Pharmaceutical Science and Herbal Technology*, vol. 1, no. 1, pp. 32–39, 2023.

[29] L. Zhang, Y. Shan, K. Tang, & R. Putheti, "Ultrasound-assisted extraction flavonoids from Lotus (*Nelumbo nuficera Gaertn*) leaf and evaluation of its anti-fatigue activity," *International Journal of Physical Sciences*, vol. 4, no. 8, pp. 418–422, 2009.

[30] P. Leksono, O. Komala, & Ismanto, "Aktivitas ekstrak daun pandan wangi (*Pandanus amaryllifolius*) dengan Metode DPPH" *Journal Of Pharmaceutical*, vol. 1, no. 2, pp. 74–85, 2013, doi: https://doi.org/10.30989/jop.v1i2.1223

[31] M. Wiritania, I. S. Muyassaroh, & B. D. Septiarifianti, "Daun Bayam Hijau Dengan Metode Ekstraksi Maserasi Dan Uji Kuantitatif Menggunakan Spektrofotometer Uv – Vis," *Jurnal Studi Multidisipliner*, vol. 8, no. 12, pp. 761–769, 2024.

[32] N. Fauziyah, A. Widyasanti, & Y. Sutresna, "Kajian Pengaruh Konsentrasi Etanol Terhadap Karakteristik Oleoresin Ampas Jahe Merah (*Zingiber officinale Roscoe*) Limbah Penyulingan," *Teknotan*, vol. 16, no. 3, p. 169, 2022, doi: https://doi.org/10.24198/jt.vol16n3.6

[33] F. I. Gunawan, S. A. Putri, V. U. Ramdhanawati, & M. Umami, "Kajian Metode Maserasi Ekstrak Daun Teh Hijau (*Camellia sinensis*) Dengan Berbagai Pelarut," *Jurnal Biology Science & Education*, vol. 13, no. 1, pp. 66–75, 2024.

[34] L. A. Hidayah & M. A. Anggarani, "Indonesian Journal of Chemical Science Determination of Total Phenolic , Total Flavonoid , and Antioxidant Activity of India Onion Extract," *Indonesian Journal of Chemical Science*, vol. 11, no. 2, pp. 124–135, 2022, doi: https://doi.org/10.15294/ijcs.v11i2.54610

[35] I. L. Ramos & T. M. B. Bandiola, "Phytochemical Screening of *Syzygium Cumini Myrtaceae* Leaf Extracts Using Different Solvents of Extraction," *Der Pharmacia Lettre* , vol. 9, no. 2, pp. 74–78, 2017.

[36] Nurhasanah & Novian, "Analisis Ekstrak Etanol Buah Labu Kuning (*Cucurbita Moschata D*)," *Jurnal Parapemikir*, vol. 9, no. 1, pp. 54–59, 2020, doi: https://doi.org/10.30591/pjif.v9i1.1758

[37] M. Syahruddin, M. Aswad, Y. D. P. A. Embu, & K. Khadijah, "Uji Aktivitas Antioksidan Ekstrak Etanol Daun Murbei (*Morus alba L*) Asal Kupang, Nusa Tenggara Timur Dengan Metode Dpph (2,2 Diphenil-1- Picrylhydrazyl)," *Techno: Jurnal Penelitian.*, vol. 8, no. 1, p. 246, 2019, doi: https://doi.org/10.33387/tk.v8i1.947

[38] A. R. Pradana, H. Wahyudi, & D. Lestari, "Rendemen Ekstrak Etanol Herba Rumput Akar WangI (*Polygala paniculata L*) Pada Perbandingan Konsentrasi Pelarut," *Jurnal Riset Kefarmasian Indonesia.*, vol. 5, no. 3, pp. 373–383, 2023, doi: https://doi.org/10.33759/jrki.v5i3.418

[39] C. Montella, Noval, & D. Kurniawati, "Formulation

and Evaluation of Karamunting Fruit Extract Nano Spray Gel (*Rhodomyrtus tomentosa (Aiton*) *Hassk* .) with Carbopol 940 Concentration Variations," *Jurnal Surya Mediaka*, vol. 10, no. 2, pp. 117–128, 2021, doi: https://doi.org/10.33084/jsm.v10i2.7733

[40] S. A. Novitri, N. N. Nurmeilis, & D. R. Kamal, "Efek antihipertensi Ekstrak Etanol Daun Belimbing Wuluh (*Averrhoa blimbing L*.) dengan Metode Non-invasiv," *Pharmaceutical and Biomedical Sciences Journal*, vol. 2, no. 1, pp. 11–18, 2020, doi: https://doi.org/10.15408/pbsj.v2i1.15235

[41] D. Luthfianto & D. Marfuah, "Aktivitas Antioksidan Teh Daun Belimbing Wuluh (*Averrhoa Bilimbi L*)," *INFOSAINTEK: Jurnal Informatika, Sains, dan Teknologi*, vol. 1, no. 1, pp. 1–8, 2022, doi: https://doi.org/10.57151/jsika.v1i1.17

[42] R. C. Rowe. *Handbook of Pharmaceutical Excipient, 6th Ed*. London: The Pharmaceutical Press. 2009

[43] N. A. Setiani, F. Nurwinda, & D. Astriany, "Pengaruh Desinfektan dan Lama Perendaman pada Sterilisasi Eksplan Daun Sukun ," *Biotropika Journal of Tropical Biology*, vol. 6, no. 3, pp. 78–82, 2018, doi: https://doi.org/10.21776/ub.biotropika.2018.006.03.01

[44] Y. M. Huselan, M. R. J. Runtuwene, & D. S. Wewengkang, "Aktivitas antioksidan ekstrak etanol, etil asetat, dan n-heksan dari daun sesewanua (*Clerodendron squamatum Vahl*.)," *Pharmacon*, vol. 4, no. 3, pp. 155–163, 2015.

[45] R. K. Wahyuningtyas, "Aktivitas Antioksidan Ekstrak Daun, Bunga, Dan Batang Pacing *(Costus speciosus*) Dengan Metode 1,1-diphenyl-2-picrylhydrazin (DPPH)," 2020. [Online]. Available: http://repository.radenintan.ac.id/id/eprint/13581

[46] D. A. P. Kumaradewi, W. A. Subaidah, Y. Andayani, & A. Al-Mokaram, "Phytochemical Screening and Activity Test of Antioxidant Ethanol Extract of Buni Leaves (*Antidesma bunius L. Spreng*) Using DPPH Method," *Jurnal Penelitian Pendidikan IPA.*, vol. 7, no. 2, pp. 275–280, 2021, doi: https://doi.org/10.29303/jppipa.v7i2.675

[47] S. Jannah, W. Hajrin, & N. I. Hanifa, "Optimasi Formula Sampo Ekstrak Etanol Daun Delima (*Punica granatum L*.) Dengan Metode Simplex Lattice Design," *Sasambo Journal of Pharmacy.*, vol. 5, no. 2, 2023, doi: https://doi.org/10.29303/sjp.v5i2.347

[48] M. Murniyati, W. A. Subaidah, & A. D. Ananto, "Formulasi Dan Uji Aktivitas Antiradikal Bebas Sediaan Gel Ekstrak Etanol Daun Bidara (*Ziziphus mauritiana Lamk*) Menggunakan Metode DPPH," *Lumbung Farm. Jurnal Ilmu Kefarmasian*, vol. 2, no. 2, p. 96, 2021, doi: https://doi.org/10.31764/lf.v2i2.5491

.