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

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

Analysis of Total Flavonoid Content in Local Kalimantan Plants and Antioxidant Activity: A Review

Nabilla Faoziyyah Azizah, Wildan Hidayah, Risa Dwi Apriani, Dia Septiani*

Department of Pharmacy, Universitas Singaperbangsa Karawang, Karawang, Indonesia
*e-mail: dia.septiani@fikes.unsika.ac.id

Received: January 05, 2026. Accepted: May 25, 2026. Published: July 9, 2026

Abstract: Flavonoids are one of the largest groups of compounds in the natural phenol group that are widely found in all types of green plants, so they are almost always found in every analysis of plant extracts. Meanwhile, antioxidants are inhibitors used to prevent autooxidation. Flavonoids have the ability to act as antioxidants because they can transfer electrons, so they can neutralize free radicals. This review identifies the levels of flavonoids and antioxidant activity of local Kalimantan plants, utilizing half-maximal inhibitory concentration (IC50) values as a standardized quantitative parameter for assessing antioxidant potency and identifying promising sources of natural antioxidants. The maceration extraction method with ethanol at concentrations of 70% and 96% was used to obtain active compounds, and antioxidant activity was assessed using the DPPH method. The results showed that several species, such as Bajakah Kalalawit (*Uncaria cordata*) and Karamunting (*Rhodomyrtus tomentosa*), had very low IC_{50} values, namely 9.159 ppm and 14.06 µg/mL, indicating very strong antioxidant activity. Thus, local Kalimantan plants have great potential as a source of natural antioxidants and could be developed as raw materials for antioxidant-based health products. The findings of this review offer comprehensive evidence to guide future research, standardization, and commercialization of indigenous Kalimantan plants for the development of effective and sustainable natural antioxidant products.

Keywords: Alkaloids; Antioxidant; Flavonoids; Local Plants of Kalimantan.

Introduction

Indonesia is known for its high biodiversity and is often called a megabiodiverse country. In the tropical forests of Indonesia, there are around 30,000 plant species, with around 9,600 known to have medicinal properties, of which around 200 are important medicinal plants for the traditional medicine industry [1]. This diversity is supported by a tropical climate and ideal geographical conditions conducive to the growth of various plant types [2]. Kalimantan is an island famous for its traditional medicine, which uses plants passed down through generations by indigenous Kalimantan tribes [3].

The people of Kalimantan preserve and apply the traditional knowledge of local tribes by utilizing a wide variety of medicinal plants for healthcare purposes. This ethnomedicinal knowledge has been inherited and developed over thousands of years, reflecting the close relationship between indigenous communities and the surrounding biodiversity. In addition to serving as an important cultural heritage, the use of medicinal plants also has strong potential to support rural development, particularly through the production of traditional herbal medicines and community-based health products [4]. Several local plant species in Kalimantan are known to contain high levels of bioactive compounds, especially flavonoids, which exhibit antioxidant activity.

Flavonoid compounds help counter free radicals, thereby preventing oxidative damage to body cells. Free radicals are atoms or molecules that have unpaired electrons, making them unstable and highly reactive. In the health sector, free radicals are a problem that often triggers various degenerative diseases. Therefore, antioxidants are needed to prevent the harmful effects of free radicals [5].

Antioxidants are inhibitors used to prevent auto-oxidation. Antioxidants can be obtained from inside or outside the body. According to their sources, antioxidants are divided into two types: natural and synthetic. The body naturally needs antioxidants to prevent the accumulation of free radicals and repair damaged cells [6].

Flavonoids are one of the largest compounds in the natural phenol group that are widely found in all types of green plants, so they are almost always found in every analysis of plant extracts [7]. Flavonoids have the ability to act as antioxidants because they can transfer electrons, so they can neutralize free radicals. Flavonoids act as reducing compounds that can inhibit various oxidation reactions. The antioxidant properties of flavonoids as free radical scavengers come from the content of hydroxyl groups. The relationship between flavonoids and antioxidants is evident in the observation that higher total flavonoid content in a material correlates with higher antioxidant activity [8].

To identify the most promising local plant species as rich sources of natural flavonoids and antioxidants, this review article aims to gather and critically assess the currently available evidence on the flavonoid content and antioxidant activity of indigenous plants from Kalimantan. To provide scientific support for their future cultivation and use as alternative sources of flavonoid-rich raw materials in herbal medicinal products, this review aims to identify native Kalimantan plants with the highest flavonoid content and strongest antioxidant potential. Additionally, it is anticipated that the results will provide a foundation for further research

How to Cite:
N. F. Azizah, W. Hidayah, R. D. Apriani, and D. Septiani, "Analysis of Total Flavonoid Content in Local Kalimantan Plants and Antioxidant Activity: A Review", *J. Pijar.MIPA*, vol. 21, no. 4, pp. 672–677, Jul. 2026. https://doi.org/10.29303/jpm.v21i4.9798

examining the pharmacological roles and effectiveness of these plants as natural antioxidants.

Research methods

The method used in this article review includes searching for research articles relevant to the topic. Relevant articles were collected through an online search using the database on Google Scholar scientific data (https://scholar.google.com/) and supported by the online search engine "Publish or Perish". In the search process, the words "flavonoid levels", "antioxidants", "Kalimantan plants", and "antioxidant activity" were used. The articles included in this review were published within the period of 2015–2024 to ensure the relevance and recency of the scientific information analyzed. The selection of articles was based on several inclusion and exclusion criteria. The inclusion criteria included (a) research on flavonoid levels, "antioxidant activity". The selection of articles was based on several inclusion and exclusion criteria. The inclusion criteria included (a) research on flavonoid levels and antioxidant activity in local Kalimantan plants, (b) research articles, (c) articles available in full text, and (d) local Kalimantan plants. Articles were filtered by reading the 'title' and 'abstract' sections. While the exclusion criteria included (a) non-research articles, (b) articles not available in full text, (c) incomplete article content, (d) irrelevant articles, and (e) plants not from Kalimantan. The final stage included a thorough reading of the selected articles in full format. The search strategy for this article review is presented in Figure 1.

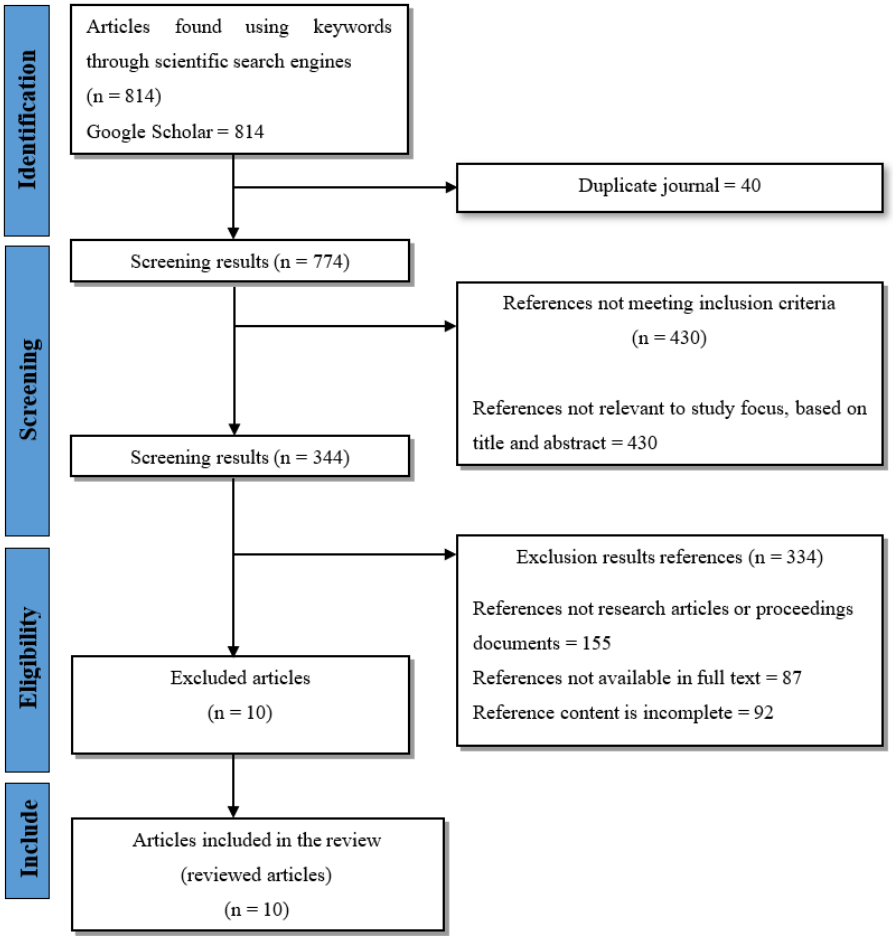

Figure 1. Diagram prism article research

Results and Discussion

Selection of Articles for Review

Natural plant-derived antioxidants have attracted considerable interest due to their potential for the development of herbal medicines. Although Kalimantan possesses rich plant biodiversity, information on the flavonoid content and antioxidant activity of its indigenous plants remains scattered and insufficiently synthesized. Therefore, this review aims to compile and evaluate published studies on the flavonoid content and antioxidant activity of local Kalimantan plants to identify species with the highest flavonoid levels and strongest antioxidant potential, as indicated by IC50 values. Relevant articles were collected, screened, and analyzed, and data on plant species, flavonoid content, and antioxidant activity were summarized. The findings are expected to identify the most promising indigenous plants as sources of natural antioxidants and provide a scientific basis for their cultivation, utilization as flavonoid-rich raw materials in herbal products, and further investigation of their potent antioxidant properties.

Table 1. Review Results

Sources	Local plant name	Parts used	Antioxidant Activity (IC_{50})	Extraction Method	Flavonoid content
[9]	Bajakah kalalawit (*Uncaria cordata* (L.) Merr.)	Stem	9.159 ppm	Maceration with 96% ethanol solvent for 6x24 hours	3.6 ± 0.086 %
[10].	Kalangkala (*Litsea angulata*)	Leaves	302.80 ppm	Maceration with 70% ethanol solvent for 3x24 hours	0.395%
[11]	Akar Kaik-kaik (*Uncaria cordata (Lour.) Merr*)	Leaves	49.22 ppm	Maceration with 70% ethanol solvent for 24 hours	9.08 mg QE/g
[12]	Balik angin (*Alphitonia excelsa*)	Stem Bark	37.00 ± 1.46 µg/ml	Maceration with 96% ethanol solvent for 72 hours	1.17% ± 0.04 QE
[13]	Buas-buas (*Premna serratifolia* L.)	Leaves	83.08 µg/mL	Maceration with 96% ethanol solvent for 3x24 hours	2.517%
[14]	Umbi bawang dayak (Eleutherine palmifolia (L.) Merr.)	Fermented tubers	28.689 µg/mL± 0.144 µg/mL	Maceration with 70% ethanol solvent for 3x24 hours	3.721 g GAE/100 g ± 0.210; 0,378 g QE/100 g ekstrak ± 0,189
[5]	Karamunting (*Rhodom yrtustome ntosa* (Aiton) Hassk)	Leaves	14.06 µg/mL,	Maceration with ethanol solvent for 5x24 hours	192,6 mgQE/g
[15]	Galam rawa gambut (*Melaleuca cajuputi roxb*)	Bark and leaves	44.4888 ppm	Maceration with ethanol solvent for 7x24 hours	0,2826 mg QE/g ekstrak
[1]	Kasturi (*Mangifera casturi Kosterm.*)	Leaves	34.558 ppm	Maceration with 70% ethanol solvent	9,31 ± 0,08 %b/b
[16]	Kajajahi (*Leucosyke capitellata Wedd.*)	Leaves	455.570 ppm	Maceration with 70% ethanol solvent for 3x24 hours	6,14 ± 0,193 mg/g

Solvent Concentration on Flavonoid Content of Local Borneo Plants

Based on the 10 journals reviewed, the extraction method used is ethanol maceration at 70% and 96% concentrations, with varying maceration times. The maceration extraction method is simple. Conventional methods such as maceration remain widely employed because of their simplicity and low operational cost. In this technique, plant material only needs to be soaked in solvent at room temperature or slightly heated.

Maceration is one of the conventional extraction methods that is still widely used for flavonoid extraction because the process is simple, inexpensive, and does not require specialized equipment [17][18]. Chaves et al. explained that maceration remains a common method for extracting flavonoids from natural materials [19]. Various studies have shown that this method is effective for extracting phenolic and flavonoid compounds because it is performed at room temperature, thereby preserving the stability of thermolabile compounds [20]. Research conducted by Sapiun et al. demonstrated that the maceration method successfully extracted flavonoids from sesewanua leaves [21]. In addition, the maceration method significantly affected the total flavonoid content of herbal plants [22]. Agitation during the maceration process is also known to improve the efficiency of flavonoid recovery [23].

Several studies have shown that the maceration method can enhance antioxidant activity due to the high flavonoid content it yields [24]. Furthermore, maceration is considered advantageous because of its low energy consumption, low operational cost, and ability to preserve heat-sensitive bioactive compounds [25][26][[27]. Kushwaha et al. also stated that this method is environmentally friendly and efficient for phytochemical extraction [28].

Extraction with 70% ethanol indicates that some plants have high flavonoid levels. Kasturi (Mangifera casturi), extracted from its leaves, has a flavonoid content of 9.31 %b/b. Kaik-kaik root (Uncaria cordata), which is also extracted from the leaves, yielded a flavonoid content of 9.08 mg QE/g, while Dayak onion bulb (Eleutherine palmifolia) yielded a flavonoid content of 3.721 g GAE/100g. Kajajahi (Leucosyke capitellata) also had moderate flavonoid levels of 6.14 ± 0.193 mg/g, and Kalangkala (Litsea angulata) had relatively low flavonoid levels of 0.395%, suggesting that 70% ethanol may not be optimal for Kalangkala plants.

In extraction with 96% ethanol, the results showed generally higher flavonoid levels, which contributed to stronger antioxidant activity. Karamunting (Rhodomyrtus tomentosa) has the highest flavonoid content, at 192.6 mg QE/g, making it the best plant source of natural antioxidants. Bajakah Kalalawit (Uncaria cordata) from its stem has a flavonoid content of 3.6 ± 0.086% w/w, while Balik Angin

(Alphitonia excelsa) and Buas-buas (Premna serratifolia) have flavonoid levels of 1.17% and 2.517%, respectively, which also show significant antioxidant potential. However, Galam Rawa Gambut (Melaleuca cajuputi) showed a lower flavonoid level of 0.2826 mg QE/g even with 96% ethanol, suggesting that the flavonoid content of this species may be lower than that of other species or may require alternative extraction techniques for optimal results [29]. Based on the results obtained, 96% ethanol was more effective at extracting higher levels of flavonoids than 70% ethanol [30], [31], [32].

Higher ethanol concentrations, such as 96%, generally dissolve semi-polar to non-polar flavonoid compounds more effectively, thereby supporting stronger antioxidant activity. The choice of solvent is important in extraction because it affects the amount and quality of active compounds obtained. Each solvent has a different level of polarity, which determines its ability to dissolve certain bioactive compounds [9]. This is related to the properties of flavonoid compounds, where less polar flavonoids, such as isoflavones, flavanones, flavones, and flavanols, are more easily extracted using nonpolar solvents, while more polar flavonoids, such as glycosides and aglycones, are more effectively extracted using alcohol or water-alcohol solvents. Therefore, the selection of solvents must be adjusted to the polarity characteristics of the flavonoids to be extracted in order to optimize the extraction process and produce higher total flavonoid content [33], [34].

Antioxidant Activity Test Method

In the analysis of antioxidant activity, several commonly used methods are available, such as DPPH, ABTS, and FRAP. The antioxidant test method used in the 10 reviewed journals is the DPPH (2,2-diphenyl-1-picrylhydrazyl) method, the standard for measuring the free radical-scavenging ability of plant extracts. The DPPH method was chosen for its simplicity, high accuracy, and ability to deliver rapid results for measuring a sample's antioxidant potential [35]. This method works based on the color change of the DPPH solution from purple to yellow or colorless when reacting with antioxidants. The results of this DPPH test provide an IC50 value for each extract, indicating the concentration required to reduce free radical activity by 50%.

IC_{50} (Inhibitory Concentration 50) is a value that indicates the concentration of extract needed to inhibit 50% of free radical activity. The IC_{50} value is an important indicator in assessing the antioxidant strength of plant extracts. The lower the IC50 value, the better the antioxidant properties. Generally, the IC_{50} value is categorized as follows [15]:
Very Potent Antioxidant: IC_{50} < 50 µg/mL or ppm.
Moderate Antioxidant: IC_{50} between 50–100 µg/mL or ppm.
Weak Antioxidant: IC50 > 100 µg/mL or ppm.

Based on research on local Kalimantan plants, several plants exhibit very strong antioxidant activity, with IC50 values below 50 µg/mL. The Bajakah Kalalawit plant (*Uncaria cordata*) has the lowest IC_{50} value, namely 9.159 ppm [36]. This finding is also in line with the study by Halisa et al. (2024) on the ethanol extract of Bajakah Kalalawit stem, which used a similar method and showed very strong antioxidant activity with an IC50 of 8.69 ppm [37], indicating a strong ability to ward off free radicals. The Karamunting plant (*Rhodomyrtus tomentosa*) has an IC_{50} of 14.06 µg/mL. The Balik Angin plant (*Alphitonia excelsa*) with an IC50 of 37.00 µg/mL, the Galam Rawa Gambut plant (*Melaleuca cajuputi*) with an IC_{50} value of 44.4888 ppm and the Akar Kaik-kaik plant (Uncaria cordata) with an IC_{50} value of 49.22 ppm, these 4 types of plants show high effectiveness as natural antioxidants, indicating strong antioxidant activity. These plants have great potential as an effective source of natural antioxidants.

Meanwhile, the Buas-buas plant (*Premna serratifolia*) is classified in the moderate antioxidant category, with an IC50 of 83.08 µg/mL, indicating a fairly good antioxidant capacity. Puspita et al. (2020) reported that the leaves of Premna serratifolia L. exhibited strong antioxidant activity, with an IC50 of 20.66 µg/mL. The difference in results may be attributed to the extraction conditions, particularly the type and concentration of the solvent used. Puspita et al. employed maceration using 70% ethanol as the extraction solvent for 3 × 24 hours, whereas the present study used different extraction conditions. These findings suggest that variations in solvent composition and extraction procedures can influence the antioxidant activity of plant extracts. However, Puspita et al. did not determine the extract's flavonoid content; therefore, it cannot be conclusively stated whether flavonoid levels contributed to the observed antioxidant activity [36].

In addition, several plants show weak antioxidant activity, with IC50 values above 100 µg/mL. Kalangkala plant (*Litsea angulata*) has an IC_{50} of 302.80 ppm, and Kajajahi plant (Leucosyke capitellata) has an IC_{50} of 455.570 ppm. Both of these plants have relatively low antioxidant activity, although Kajajahi has quite high flavonoid levels. The antioxidant activity of Kajajahi plant extract using the DPPH method and reported an IC50 of 9.889 ppm in 70% ethanol, indicating very strong antioxidant activity [37]. Therefore, further supporting studies are needed to compare IC50 values using the same solvent system while carefully considering the DPPH method parameters applied in each study [38].

The evaluation of antioxidant activity is essential for determining the ability of plants to neutralize free radicals and identifying species with the strongest antioxidant potential. However, flavonoid levels are not always directly correlated with antioxidant activity, as antioxidant effectiveness also depends on the specific types of flavonoids present and the contribution of other bioactive compounds [39]. Therefore, this review helps identify native Kalimantan plants with high flavonoid content and potent antioxidant activity, providing a scientific basis for developing these plants as potential sources of flavonoid-rich raw materials and natural antioxidant agents in herbal medicine [40].

Conclusion

Local plants in Kalimantan exhibit high flavonoid levels and antioxidant activity, with several species showing potential as natural antioxidant sources. Of the 10 plants, the Bajakah Kalalawit is *Uncaria cordata* (Lour.). Merr. has very strong antioxidant activity, with a low IC50 of 9.159 ppm, indicating a strong ability to ward off free radicals and making it the most effective natural antioxidant. Antioxidant

activity is not always proportional to flavonoid levels, because it is influenced by the type of compound and the extraction method used.

Author's Contribution

N.F. Azizah: was responsible for reviewing relevant literature, organizing the collected information, and assisting in the development of the manuscript. W. Hidayah: contributed to the design of the study approach, the selection of research methods, and the evaluation of the information obtained. R.D. Apriani: participated in collecting references and preparing the first version of the manuscript. D. Septiani: contributed to developing the paper's main ideas and improving the manuscript.

Acknowledgement

The authors gratefully acknowledge the Department of Pharmacy, Faculty of Health Sciences, for providing academic assistance and facilities that supported the completion of this work. Appreciation is also given to all colleagues and collaborators who contributed through discussions, suggestions, and valuable feedback during the preparation of this manuscript.

References

[1] A. Bakti, L. Triyasmono, and M. I. Rizki, "Penentuan Kadar Flavonoid Total dan Uji Antioksidan Ekstrak Etanol Daun Kasturi (Mangifera casturi Kosterm.) dengan Metode DPPH," *Jurnal Pharmascience*, vol. 04, no. 01, pp. 102–108, 2017, [Online]. Available: http://jps.unlam.ac.id/

[2] H. Manurung, D. Susanto, and R. Z. Hapsari, "Uji Kandungan Metabolit Sekunder dan Aktivitas Antioksidan Ekstrak Etanol Daun Lai (Durio kutejensis) (Hassk.) (Becc.) dengan Metode DPPH (2,2-diphenyl-1-picrylhydrazyl)," *EduBiologia: Biological Science and Education Journal*, vol. 3, no. 2, p. 65, Jul. 2023, doi: 10.30998/edubiologia.v3i2.18431.

[3] R. zuri P. Rawambaku, "Analisis Metabolit Sekunder Dan Aktivitas Antioksidan Ekstrak Etanol Daun Buas-Buas Dengan Metode Spektrofotometri Uv-Vis," *Farmakologika : Jurnal Farmasi*, vol. 19, no. 2, pp. 167–179, Feb. 2023, doi: 10.56730/farmakologika.v19i2.486.

[4] T. A. Nina Sari, D. Nurfitriani, R. Mutamimah, Yudianto, and A. Z. Wakhidah, "The Diversity of Medicinal Plant Used by Local Community in Borneo, Indonesia: A Review," *Jurnal Jamu Indonesia*, vol. 10, no. 1, pp. 24–39, Jan. 2025, doi: 10.29244/jji.v10i1.324.

[5] R. Dona, "Determination of Total Phenolic, Total Flavonoid and Antioxidant Activity of Karamunting Leaves (Rhodomyrtus tomentosa (Aiton) Hassk) Extract and Fraction," *Jurnal Penelitian Farmasi Indonesia*, vol. 9, no. 2, pp. 72–78, Jan. 2021, doi: 10.51887/jpfi.v9i2.975.

[6] Haeria, Hermawati, and A. T. U. Dg. Pine, "Penentuan Kadar Flavonoid Total dan Aktivitas Antioksidan Ekstrak Etanol Daun Bidara (Ziziphus spina-christi L.)," *Journal of Pharmaceutical and Medicinal Sciences*, vol. 1, no. 2, pp. 57–61, 2016.

[7] T. Nurmalasari *et al.*, "Uji Aktivitas Antioksidan Ekstrak Buah Kupa (Syzygium Polycephalum) Terhadap Radikal Bebas Dengan Metode Dpph," 2016.

[8] E. F. Yanti and N. Purwanti, "Penetapan Kadar Falvonoid Total Dan Uji Aktivitas Ekstrak Etanol Daun Makadamia (Macadamia integrifolia) Dengan Metode DPPH," *Journal of Islamic Pharmacy*, vol. 7, no. 2, pp. 100–103, Jan. 2023, doi: 10.18860/jip.v7i2.17522.

[9] N. Wathan, N. R. Safarina, and M. Fitriana, "Aktivitas antioksidan dan kandungan flavonoid total ekstrak etanol batang bajakah kalalawit (Uncaria cordata (Lour) Merr.) asal Kecamatan Loksado Kalimantan Selatan," *Sasambo Journal of Pharmacy*, vol. 5, no. 1, pp. 1–8, Apr. 2024, doi: 10.29303/sjp.v5i1.230.

[10] M. I. Rizki, L. Triyasmono, and R. A. Rizky, "Aktivitas Antioksidan Dan Kadar Flavonoid Total Ekstrak Daun Kalangkala (Litsea Angulata)," *Journal of Current Pharmaceutical Sciences*, vol. 7, no. 1, pp. 696–701, 2023.

[11] S. Deswita, E. N. Rahma, V. Celloce Njurumana, and R. Yanuarti, "Pengujian Flavonoid Total Dan Uji Aktivitas Antioksidan Fraksi Aktif Daun Akar Kaik-Kaik (Uncaria cordata (Lour.) Merr) Yang Berpotensi Sebagai Obat Diare," *Jurnal Biologi dan Pembelajarannya*, 2022, [Online]. Available: https://ojs.unpkediri.ac.id/index.php/biologi

[12] S. Hadi, A. Muliana, and A. Khairunnisa, "Uji Flavonoid Total dan Antioksidan Kulit Batang Balik Angin (Alphitonia excelsa (Fenzl) Reis Ex. Endl)," 2022.

[13] P. R, "Analisis Metabolit Sekunder dan Aktivitas Antioksidan Ekstrak Etanol Daun Buas-Buas dengan Metode Spektrofotometri UV-VIS," *Farmakologika Jurnal Farmasi*, vol. 19, no. 2, pp. 168–179, 2022.

[14] S. Nurlaela Fitriansyah *et al.*, "Kandungan Kimia Dan Aktivitas Antioksidan Pada Umbi Bawang Dayak (Eleutherine Palmifolia (L.) Merr.) Hasil Fermentasi," *JSTFI Jurnal Sains dan Teknologi Farmasi Indonesia*, vol. X, no. 2, 2021.

[15] R. Roro Ariessanty Alicia Kusuma Wardhani *et al.*, "Analisis Skrining Fitokimia, Kadar Total Fenol-Flavonoid Dan Aktivitas Antioksidan Ekstrak Etanol Kulit Kayu Tanaman Galam Rawa Gambut (Melaleuca Cajuputi Roxb)," 2018.

[16] I. Ipandi, L. Triyasmono, and B. Prayitno, "Penentuan Kadar Flavonoid Total dan Aktivitas Antioksidan Ekstrak Etanol Daun Kajajahi (Leucosyke capitellata Wedd.)," *Jurnal Pharmascience*, vol. 3, no. 1, 2016, [Online]. Available: http://jps.ppjpu.unlam.ac.id/

[17] A. Wojdyło, J. Samoticha, and J. Chmielewska, "Effect of different pre-treatment maceration techniques on the content of phenolic compounds and color of Dornfelder wines elaborated in cold climate," *Food Chem.*, vol. 339, p. 127888, Mar. 2021, doi: 10.1016/j.foodchem.2020.127888.

[18] M. Błaszak, S. Lachowicz-Wiśniewska, I. Kapusta, M. Szewczuk, and I. Ochmian, "Enhanced Extraction of Polyphenols, Physicochemical Properties, and Microbial Control in Vitis vinifera L. Juice Using Ultrasound-Assisted Maceration," *Molecules*, vol. 30,

no. 3, p. 587, Jan. 2025, doi: 10.3390/molecules30030587.

[19] J. O. Chaves *et al.*, "Extraction of Flavonoids From Natural Sources Using Modern Techniques," Sep. 25, 2020, *Frontiers Media S.A.* doi: 10.3389/fchem.2020.507887.

[20] A. F. Alfiana, "A Comparison of Maceration and Soxhletation Extraction Methods," *Ekliptika Journal*, vol. Vol. 5, No. 1, 2024.

[21] Z. Sapiun, P. Pangalo, A. Imran, P. S. Wicita, and R. P. A. Daud, "Determination of Total Flavonoid Levels of Ethanol Extract Sesewanua Leaf (Clerodendrum Fragrans Wild) With Maseration Method Using UV-Vis Spectrofotometry," *Pharmacogn J*, vol. 12, no. 4, pp. 1–5, Aug. 2020, doi: 10.5530/pj.2020.12.

[22] R. Ulvia, D. Nurhasanah, A. Camelia, and L. Widianingrum, "The Effect of Extraction Method on Total Flavonoid Content of Hedyotis corymbosa L.," *Journal of Biotechnology and Natural Science*, vol. 5, no. 1, pp. 40–47, Jun. 2025, doi: 10.12928/jbns.v5i1.13187.

[23] D. S. Ramadhani and H. Parbuntari, "Pengaruh Metode Ekstraksi Maceration Vortex Technique terhadap Kadar Total Flavonoid pada Daun Kersen (Muntingia calabura L.)," *TSAQOFAH*, vol. 5, no. 5, pp. 4811–4820, Jul. 2025, doi: 10.58578/tsaqofah.v5i5.6910.

[24] Danang Raharjo, Bagas Ardiyantoro, and Anastasia Cindy Jovita Putri, "Correlation between Extraction Method, Phenolic Content, and Antioxidant Activity in Red Pedada Leaves (Sonneratia caseolaris L.)," *International Journal Of Health Science*, vol. 5, no. 3, pp. 457–468, Nov. 2025, doi: 10.55606/ijhs.v5i3.6063.

[25] M. Andry *et al.*, "The Effect of Different Methods of Maceration and Microwave Assisted Extraction (MAE) on Determining Flavonoid Contents of Total Figs (Ficus racemosa L)," *Journal of Pharmaceutical and Sciences*, pp. 799–809, May 2025, doi: 10.36490/journal-jps.com.v8i2.859.

[26] S. M. A. Alelah, A. I. Abdulrazzaq, M. O. Hussein, S. J. Nasser, and A. K. Mssdf, "Overview of extraction methods for phytochemicals: Principles, applications, and future directions," *Results Chem.*, vol. 24, p. 103221, May 2026, doi: 10.1016/j.rechem.2026.103221.

[27] C. Ojong, S. A. Besong, and A. N. A. Aryee, "Solvent-Based Extraction Recovers Phytochemicals from Medicinal Plants Demonstrating Anticancer and Chemopreventive Potential: A Review," Apr. 01, 2026, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/molecules31071202.

[28] A. Kushwaha, V. Kumar, Y. Gat, N. Kumar, A. Parashar, and D. J. Pinakin, "Microbial maceration: a sustainable approach for phytochemical extraction," *3 Biotech*, vol. 8, no. 9, p. 401, Sep. 2018, doi: 10.1007/s13205-018-1423-8.

[29] O. T. Mahardani and L. Yuanita, "Efek Metode Pengolahan Dan Penyimpanan Terhadap Kadar Senyawa Fenolik Dan Aktivitas Antioksidan," *Unesa Journal of Chemistry*, vol. 10, no. 1, pp. 64–78, Jan. 2021, doi: 10.26740/ujc.v10n1.p64-78.

[30] I. Anwar, Parawansah, Yamin, R. Malina, and A. Fitri, "Penentuan Kadar Fenolik, Flavonoid dan Uji Aktivitas Antiinflamasi Daun Kelor (Moringa oleifera) Terhadap Penghambatan Denaturasi Protein," *Lansau: Jurnal Ilmu Kefarmasian*, vol. 2, no. 2, pp. 110–123, Dec. 2024, doi: 10.33772/lansau.v2i2.29.

[31] R. Kurniasari, M. Suzery, and B. Cahyono, "Analysis of Total Phenolics, Flavonoids, and Antioxidant Activity of Cashew Leaf Extract (Anacardium occidentale L.) with Varying Ethanol Concentrations," *Jurnal Riset Kimia*, vol. 15, no. 2, pp. 116–130, Sep. 2024, doi: 10.25077/jrk.v15i2.735.

[32] E. Pujiastuti and D. El'Zeba, "Perbandingan Kadar Flavonoid Total Ekstrak Etanol 70% dan 96% Kulit Buah Naga Merah (Hylocereus polyrhizus) dengan Spektrofotometri," *Cendekia Journal of Pharmacy*, vol. 5, pp. 28–43, 2021.

[33] M. Y. Ovando-Dominguez, M.C. Lujan-Hidalgo, and D.Goncalez-Mendoza, "Total Phenols, Flavonoid and Antioxidant Activity in Annona muricata and Annona purpurea Callus Culture," *TechScience Press*, vol. 88, 2019, doi: 10.32604/phyton.2019.0654627.

[34] S. Aryal, M. K. Baniya, K. Danekhu, P. Kunwar, R. Gurung, and N. Koirala, "Total Phenolic content, Flavonoid content and antioxidant potential of wild vegetables from western Nepal," *Plants*, vol. 8, no. 4, Apr. 2019, doi: 10.3390/plants8040096.

[35] M. Arsyad, "Studi Etnobotani Tumbuhan Obat Oleh Masyarakat Desa Sidorejo Kecamatan Tamban Kabupaten Barito Kuala," 2018.

[36] W. Puspita, D. Yuspita Sari, and I. Ristia Rahman, "Uji Aktivitas Antioksidan Ekstrak Etanol Daun Buas-Buas (Premna Serratifolia L.) Asal Kabupaten Melawi Provinsi Kalimantan Barat Dengan Metode DPPH," *Jurnal Insan Farmasi Indonesia*, vol. 3, no. 2, pp. 405–412, Dec. 2020, doi: 10.36387/jifi.v3i2.532.

[37] N. Halisa, A. Frethernety, S. Permatasari, F. D. Alexandra, and Y. Ysrafil, "Aktivitas Antioksidan Ekstrak Etanol Bajakah Kalalawit (Uncaria gambir (W.Hunter) Roxb) Menggunakan Metode DPPH," *Jurnal Surya Medika*, vol. 10, no. 2, pp. 144–150, Aug. 2024, doi: 10.33084/jsm.v10i2.6151.

[38] A. Nashroh binti Dahlan, M. Abdul Halim, Z. Amiruddin Zakaria, and R. Azli Mohd Mokhtar, "Evaluation of Total Phenolic Content and Antioxidant Activity in Aqueous and Ethanolic Extracts of Leucosyke capitellata," *Borneo International Journal of Biotechnology (BIJB)*, vol. 4, pp. 51–59, 2024, doi: 10.51200/bijb.v4i.6006.

[39] H. Suhendy, D. S. Nurjanah, and I. Rahmiyani, "Korelasi Flavonoid Total Dengan Aktivitas Antioksidan Ekstrak Dan Fraksi Daun Puring Kura (Codiaeum variegatum L.)," 2024.

[40] M. Hidayatullah, A. N. Rakhmatullah, and D. Perdana, "Penetapan Kadar Fenolik Total Dan Flavonoid Total Ekstrak Etanol Batang Bajakah Tampala (Spatholobus littoralis hassk.)," *Journal of Pharmacopolium*, vol. 6, no. 2, pp. 41–52, 2023.