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Original Article

Comparison of Ethyl Acetate and Ethanol Solvents on Total Flavonoid Content from *(Gnetum gnemon L.)* Using UV-Vis Spectrophotometry

Perbandingan Pelarut Etil Asetat dan Etanol terhadap Kandungan Flavonoid Total dari (Gnetum gnemon L.) Menggunakan Spektrofotometri UV-Vis

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Abstract

Melinjo peel (*Gnetum gnemon* L.) is an agricultural by-product that is generally underutilized, despite its high content of flavonoid compounds with potential antioxidant activity. This study aimed to compare the effectiveness of ethanol and ethyl acetate as extraction solvents for flavonoids from melinjo peel (*Gnetum gnemon* pericarp) based on differences in solvent polarity. Extraction was carried out using the maceration method, followed by quantitative analysis using UV-Vis spectrophotometry. Sample preparation involved drying and pulverizing the melinjo peel, extraction with ethanol and ethyl acetate at a material-to-solvent ratio of 1:10, phytochemical screening, thin-layer chromatography analysis, preparation of a quercetin calibration curve, and determination of total flavonoid content. Total flavonoid content was determined through the formation of a complex with aluminum chloride, and absorbance was measured at a wavelength of approximately 430 nm. Statistical analysis was conducted to evaluate differences between the two solvents. The results demonstrated that the ethanol extract produced a higher total flavonoid content (51.86 mg quercetin equivalent per gram of extract) compared to the ethyl acetate extract (46.05 mg quercetin equivalent per gram). The higher extraction efficiency of ethanol is attributed to its greater polarity, which enhances the solubilization of polar flavonoid compounds. In conclusion, ethanol is a more effective solvent than ethyl acetate for extracting flavonoids from melinjo peel, and these findings support the potential utilization of melinjo peel as a natural source of bioactive compounds for applications in the food, pharmaceutical, and cosmetic industries.

Abstrak

Kulit melon (*Gnetum gnemon* L.) merupakan produk sampingan pertanian yang umumnya kurang dimanfaatkan, meskipun memiliki kandungan senyawa flavonoid yang tinggi dengan potensi aktivitas antioksidan. Studi ini bertujuan untuk membandingkan efektivitas etanol dan etil asetat sebagai pelarut ekstraksi flavonoid dari kulit melon (*perikarp Gnetum gnemon*) berdasarkan perbedaan polaritas pelarut. Ekstraksi dilakukan menggunakan metode maserasi, diikuti dengan analisis kuantitatif menggunakan spektrofotometri UV-Vis. Preparasi sampel meliputi pengeringan dan penghancuran kulit melon, ekstraksi dengan etanol dan etil asetat dengan rasio bahan terhadap pelarut 1:10, skrining fitokimia, analisis kromatografi lapis tipis, pembuatan kurva kalibrasi kuersetin, dan penentuan kandungan flavonoid total. Kandungan flavonoid total ditentukan melalui pembentukan kompleks dengan aluminium klorida, dan absorbansi diukur pada panjang gelombang sekitar 430 nm. Analisis statistik dilakukan untuk mengevaluasi perbedaan antara kedua pelarut tersebut. Hasil penelitian menunjukkan bahwa ekstrak etanol menghasilkan kandungan flavonoid total yang lebih tinggi (51,86 mg setara kuersetin per gram ekstrak) dibandingkan dengan ekstrak etil asetat (46,05 mg setara kuersetin per gram). Efisiensi ekstraksi etanol yang lebih tinggi disebabkan oleh polaritasnya yang lebih besar, yang meningkatkan pelarutan senyawa flavonoid polar. Kesimpulannya, etanol merupakan pelarut yang lebih efektif daripada etil asetat untuk mengekstrak flavonoid dari kulit melinjo, dan temuan ini mendukung potensi pemanfaatan kulit melinjo sebagai sumber alami senyawa bioaktif untuk aplikasi di industri makanan, farmasi, dan kosmetik.

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INTRODUCTION

Gnetum gnemon L., commonly known as melinjo, belongs to the family Gnetaceae and thrives in tropical regions, particularly in Indonesia[1]. While its seeds are widely used in traditional products like crackers (emping), the pericarp, typically discarded as agricultural waste harbors bioactive compounds with antioxidant and antibacterial potential, notably flavonoids. These polyphenols exhibit robust biological activities, including radical scavenging to mitigate oxidative stress, a key precursor to degenerative diseases[2,3]. Flavonoids neutralize free radicals, activate endogenous antioxidant enzymes, and prevent cellular damage. They also exert anti-inflammatory effects by inhibiting pro-inflammatory signaling pathways, such as NF-κB, while reducing cytokines (e.g., TNF-α, IL-6), cyclooxygenase-2 (COX-2), and inducible nitric oxide synthase (iNOS)[4]. Adequate dietary intake correlates with reduced risks of cardiovascular disease, type 2 diabetes, dementia, and cancer angiogenesis, underscoring their relevance in public health[5].

The pursuit of natural antioxidants for food, cosmetics, and pharmaceuticals necessitates efficient extraction methods from local sources like melinjo pericarp. Solvent selection is paramount, governed by the "like dissolves like" principle, where polarity dictates solubility[3,5]. Flavonoids span polar to semi-polar structures, making solvent polarity a critical determinant of extraction yield. Ethanol, a polar protic solvent, effectively dissolves polar phenolics and is favored for its safety, availability, and food-grade status, especially in aqueous mixtures (30-70% v/v). Ethyl acetate, semi-polar, excels in fractionating intermediate-polarity flavonoids, yielding purer fractions despite potentially lower crude extracts. Comparing these solvents elucidates polarity's impact on total flavonoid extraction efficiency from melinjo pericarp platform and strictly[6,7].

This study compares ethanol and ethyl acetate for maceration-based extraction of total flavonoids from G. gnemon L. pericarp, quantified via UV-Vis spectrophotometry at 430 nm post-$AlCl_3$ complexation[8]. Maceration, a simple, cost-effective room-temperature soaking technique, ensures equilibrium extraction despite longer durations. Melinjo, a gymnosperm originating from Indo-Malaya and Melanesia, reaches 25-30 m in height with a lifespan exceeding a century. National production exceeded 2.4 million quintals in 2024[7,9]. Its oval leaves, monopodial stems (10-20 cm diameter), and multilayered seeds support versatile uses: leaves and seeds as vegetables, bark for ropes and composites, wood for paper, and traditional remedies for vision issues or bites[10].

Phytochemical screening confirms flavonoids alongside stilbenoids (e.g., resveratrol, gnetin), tannins, saponins, alkaloids, and polyphenols, conferring antioxidant and cytotoxic properties. Thin-layer chromatography (TLC) separates compounds based on adsorption and solubility, using silica gel stationary phases and solvent mixtures, enhanced by high-performance variants (HPTLC) or densitometry for quantification[11,12].

UV-Vis spectrophotometry provides accurate, sensitive quantification of bioactive concentrations via linear regression (high R^2), though selectivity limitations necessitate derivatization or prior fractionation. Validation per international guidelines ensures reliability[13]. Preliminary assays, Shinoda for flavonoids (pink/orange with Mg/HCl), Dragendorff/Mayer/Wagner for alkaloids (orange/red precipitates), foam test for saponins, and $FeCl_3$ for tannins, verify metabolite presence[14]. By valorizing melinjo pericarp waste, this research advances sustainable sourcing of natural actives, informing pharmaceutical and food industries amid rising demand for plant-based health products.

However, studies comparing the effectiveness of ethanol and ethyl acetate solvents in extracting total flavonoids from melinjo pericarp (Gnetum gnemon L.) are still limited. Solvent selection greatly affects the flavonoid

content obtained and its potential as a natural antioxidant source. In addition, melinjo peel is often considered agricultural waste despite containing bioactive compounds with potential applications in pharmaceutical, food, and cosmetic fields. Therefore, this study aims to compare the effect of ethanol and ethyl acetate solvents on the total flavonoid content of melinjo pericarp extract using UV-Vis spectrophotometry to determine the more effective solvent. The results of this study are expected to provide scientific information regarding optimal flavonoid extraction and support the utilization of melinjo peel as a valuable natural resource.

METHODS

This study employed a pre-experimental design. A single dependent variable was selected, though other confounding variables may influence it. The research utilized a Randomized Block Design (RBD), a straightforward approach to assess the impact of independent variables (solvents: ethanol vs. ethyl acetate) on the dependent variable (total flavonoid content from *Gnetum gnemon* L. pericarp), as measured by UV-Vis spectrophotometry.

Materials

Materials. *Gnetum gnemon* L. pericarp, ethyl acetate (EtOAc), 96% ethanol, quercetin standard.

Research Procedure

Sample Preparation

Gnetum gnemon L. pericarp was thoroughly washed, oven dried at 40°C to low moisture content, and pulverized into fine powder using a blender. The powder was stored in airtight containers prior to extraction.

Extraction Process

Fifty grams of pericarp powder were macerated separately with 500 mL ethyl acetate and 96% ethanol (10:1 v/w ratio) for 2 × 24 h with intermittent agitation. Extracts were filtered and concentrated to viscous residue using a water bath at 50°C.

Phytochemical Screening

Qualitative analysis identified secondary metabolites (alkaloids, flavonoids, saponins, tannins) in *G. gnemon* L. pericarp extracts. Alkaloids were tested with Dragendorff, Mayer, and Wagner reagents (positive: orange brown precipitates). Flavonoids via Shinoda test (Mg filings + conc. HCl; positive: red-orange color)[15]. Saponins by foam test (stable foam ≥1 cm in distilled water). Tannins with 1% $FeCl_3$ (positive: dark green-black or deep blue color)[16].

Thin Layer Chromatography (TLC)

TLC analysis detected flavonoids in extracts on silica gel GF_{254} plates (1 cm spot separation). Mobile phase: n-butanol: acetic acid:water (4:1:5 v/v/v). Plates were developed, air-dried, and visualized under UV light (254/366 nm) for flavonoid fluorescence, followed by 5% $AlCl_3$ spray (yellow/olive-green spots confirmatory). Rf values calculated relative to the solvent front and compared with the quercetin standard[17].

Total Flavonoid Content Assay

One mL extract was mixed with 1 mL 10% $AlCl_3$ and 1 mL 1 M sodium acetate, diluted to 10 mL with distilled water, and incubated for 30 min. Absorbance measured at λ_{max} ≈ 430 nm using Uv-Vis spectrophotometer against a quercetin standard curve[18].

Quercetin Standard Curve Preparation

Quercetin stock solution (10–50 ppm) was prepared, and absorbance was measured at λ_{max}. Linear regression ($y = bx + a$, $r^2 > 0.99$) plotted concentration vs. absorbance for total flavonoid quantification (mg QE/g extract)[11].

Data Analysis

UV-Vis spectrophotometric absorbance data were processed using the linear regression equation derived from the quercetin standard curve. Total flavonoid content from each solvent was calculated as mg quercetin equivalents per gram extract (mg QE/g). One-way ANOVA ($\alpha = 0.05$) was subsequently applied to determine significant differences between solvents on total flavonoid yield.

RESULT AND DISCUSSION

Extract Preparation

Extraction of *Gnetum gnemon* L. pericarp was performed using maceration with ethanol and ethyl acetate solvents. This method was selected for its simplicity and avoidance of heating, minimizing degradation of heat-sensitive secondary metabolites, particularly flavonoids, while facilitating optimal diffusion from plant matrix to the solvent.

Table 1. Extract Yield from *G. gnemon* L. Pericarp

Crude material weight	Extract weight	Yield (%)
560 g	85 g	15,17%

Ethanol extraction yielded higher extractive value (15.17%) compared to ethyl acetate. Ethanol's polar to semi polar nature effectively solubilizes polar secondary metabolites (flavonoids, tannins, saponins), whereas semi polar ethyl acetate preferentially extracts intermediate polarity compounds, resulting in lower overall yield. Ethanol extract yield data from 560 g crude material (85 g extract) is presented in Table 1.

Phytochemical Screening

Qualitative phytochemical analysis of ethanol extract confirmed flavonoids, alkaloids, saponins, and tannins. Flavonoid test (Shinoda) produced orange-red coloration via flavilium ion formation from carbonyl reduction. Alkaloids yielded characteristic precipitates with Mayer, Dragendorff, and Wagner reagents. Saponins formed stable foam (>1 cm) in distilled water tannins produced dark green-black color with $FeCl_3$ due to phenolic-iron complexation[19]. Complete screening results are shown in Table 2.

Table 2. Phytochemical Screening Results

Compound	Reagent	Test Result	Conclusion
Alkaloid	Dragendorff	Orange precipitate	+
	Mayer	White precipitate	+
	Wagner	Brown precipitate	+
Flavonoid	Mg + conc. HCl (Shinoda)	Reddish-brown color	+
Saponin	Vigorous shaking in water	Stable foam (>1 cm, HCl-labile)	+
Tannin	$FeCl_3$ 1%	Dark green-black color	+

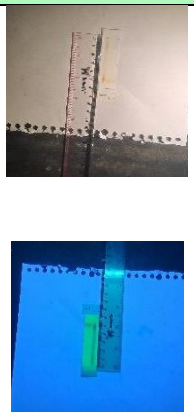
Thin Layer Chromatography (TLC)

TLC analysis revealed spots migrating 5.3 cm while the eluent front advanced 6.0 cm, yielding an Rf value of 0.88. This relatively high Rf indicates that flavonoids in the *Gnetum gnemon* L. pericarp extract exhibit lower polarity

relative to the stationary phase (silica gel), enabling greater migration with the mobile phase [18,20]. This observation aligns with characteristics of flavonoid aglycones, which are typically less polar than their glycosylated counterparts [21].

The quercetin marker exhibited a migration distance of 5.0 cm (Rf 0.83). The close similarity in Rf values between sample spots and quercetin marker supports the identification of flavonoids in the extract. Visual documentation under both visible light and ultraviolet irradiation (254/366 nm) further confirmed characteristic flavonoid spots, which typically exhibit distinctive fluorescence at specific wavelengths. Results are summarized in Table 3.

Table 3. Thin Layer Chromatography (TLC) Analysis

Compound	Spot Distance (cm)	Eluent Front (cm)	Rf Value	Marker Distance (cm)	Documentation
Flavonoid	5.3	6	0,88	5	

The TLC results showed Rf values of 0.88 for the sample and 0.83 for quercetin, indicating the presence of flavonoid compounds, likely quercetin or related flavonols, in Gnetum gnemon L. pericarp extract. These findings are consistent with previous studies reporting similar Rf values using the same mobile phase system. Phytochemical screening also confirmed the presence of flavonoids, alkaloids, saponins, and tannins, in agreement with earlier research on melinjo peel extracts. In addition, the positive Shinoda test supported the presence of flavonoids through the characteristic red-orange coloration formed during the reaction.

Total Flavonoid Content Analysis

Total Flavonoid Content Analysis of Ethanol Extract from *G. gnemon* L. Pericarp

Total flavonoid content in the ethanol and ethyl acetate extract of *Gnetum gnemon* L. pericarp was determined using UV-Vis spectrophotometry based on flavonoid-$AlCl_3$ complex formation[23]. This method is widely adopted for flavonoid analysis due to its high sensitivity and reproducibility. Absorbance measurements were recorded at the maximum wavelength of approximately 430 nm[22,23].

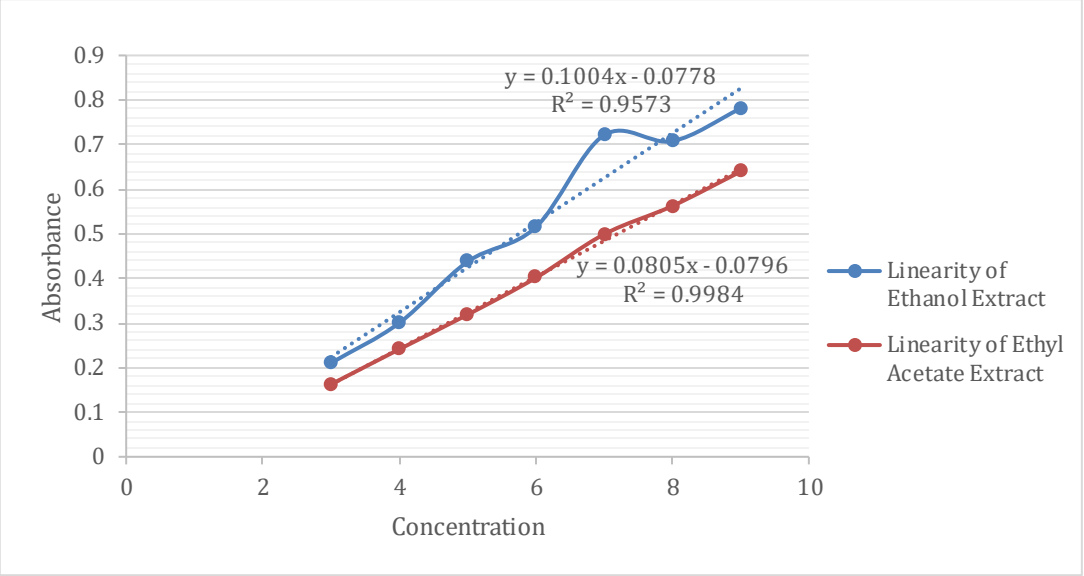


Figure 1. Quercetin Standard Calibration Curve

The calibration curve for the ethanol extract is depicted in Figure 1, with a linear regression equation of y=0.1004x-0.0778. and the calibration curve for the ethyl acetate extract is shown in Figure 1, with a linear regression equation of y=0.0805x-0.0796. The coefficient of determination (r^2) approaching one confirms excellent linearity, validating the curves for flavonoid quantification in the samples.

Table 4. Comparison of Total Flavonoid Content of *Gnetum gnemon* L. Pericarp Extracts Using Ethanol and Ethyl Acetate Solvents

Solvent	Repliclasion 1	Repliclasion 2	Replicasion 3	Mean Absorbance	Total Flavonoid Content (mg QE/g)
Ethanol	5,1725	5,0558	5,1622	5,1302	51,86
Ethyl Acetate	3,9124	3,7651	3,8626	3,8647	46,05

Calculation of total flavonoid content of ethanol extract of melinjo skin

Replication 1= 5,1725, Replication 2= 5,0558, Replication 3= 5,1622

Mean Absorbance: $= \frac{5,1725 + 5,0558 + 5,1622}{3} = 5,1302$

Quercetin Equivalent Concentration: $= \frac{y + 0,778}{0,1004}$

$= \frac{5,1302 + 0,778}{0,1004} = \frac{5,208}{0,1004} = 51,86$ µg/ml

Concentration Conversion $= \frac{c \times v}{m}$

$= \frac{51,86 \times 50}{50}$

= 51,86 mgQE/g

Calculation of total flavonoid content of ethyl acetate extract of melinjo skin

Replication 1 = 3,9124, replication 2 = 3,7651, replication 3 = 3,8626

Mean Absorbance $= \frac{3,9124 + 3,7651 + 3,8626}{3} = 3,8647$

Quercetin Equivalent Concentration $= \frac{y+0,778}{0,1004}$

$= \frac{5,1302+0,778}{0,1004} = \frac{3,8467+0,778}{0,1004}$ = 4,6247/0,1004

=46,05 µg/mL

Concentration Conversion $= \frac{c \times v}{m}$

$= \frac{46,05 \times 50}{50}$

= 46,05 mgQE/g

Based on Table 4, the ethanol extract yielded a significantly higher total flavonoid content (51.86 mg QE/g) compared to the ethyl acetate extract (46.05 mg QE/g), representing a difference of 5.81 mg QE/g (approximately 10.8%). This outcome aligns with the fundamental principle of "like dissolves like," whereby a polar solvent such as ethanol preferentially dissolves polar compounds, including the majority of flavonoid glycosides and hydroxylated aglycones present in plant matrices. These findings are consistent with a study by Nawaz et al, on Phaseolus vulgaris seeds, which demonstrated that ethanol yielded significantly greater total phenolic and flavonoid content than less polar solvents, attributed to ethanol's capacity to disrupt hydrogen bonds and penetrate the plant cell matrix more effectively[5]. Similarly, Palaiogiannis et al reported that successive solvent extraction of Cistus creticus leaves yielded higher polyphenol fractions with more polar solvents, corroborating polarity-dependent extraction efficiency[13].

The lower flavonoid yield from ethyl acetate (46.05 mg QE/g) reflects its semi-polar nature, which selectively extracts intermediate-polarity flavonoids such as flavonoid aglycones rather than the more abundant polar glycosylated forms. This is consistent with the findings of Parhusip et al, who reported that ethyl acetate extracts of red melinjo (*Gnetum gnemon* L.) peel exhibited distinct phytochemical profiles dominated by semi-polar constituents, including stilbenoid compounds such as resveratrol[7]. Kozhantayeva et al similarly observed that ethyl acetate fractions of Chamaenerion latifolium produced lower total flavonoid content compared to ethanol fractions, though with greater selectivity for specific aglycone subclasses[10]. These comparative findings suggest that while ethyl acetate may be suitable for targeted isolation of specific flavonoid classes, ethanol remains superior for total flavonoid recovery.

The total flavonoid content obtained in this study (51.86 mg QE/g for ethanol extract) is comparable to values reported in the literature for other plant pericarps and natural sources. Aminah et al reported total flavonoid content of avocado peel ethanol extract ranging from 10.29 to 27.32 mg QE/g, suggesting that G. gnemon L. pericarp is a considerably richer source of flavonoid[21]. Furthermore, Hayat et al determined total flavonoid content in Marrubium vulgare at 34.5 mg QE/g, again lower than the values found in this study, reinforcing the potential of melinjo pericarp as a high-yield natural flavonoid source[24]. the semi-polar fraction retains significant bioactivity[7]. Together, these comparisons position melinjo pericarp as a promising and competitive raw material for natural bioactive compound development, with ethanol extraction as the preferred method for maximum flavonoid recovery.

The reliability of the UV-Vis spectrophotometric method employed in this study is substantiated by the high linearity of the quercetin calibration curves (r2 approaching 1.0) for both ethanol and ethyl acetate extracts. Shraim et al conducted a critical evaluation of the AlCl3 colorimetric assay and affirmed its wide applicability for total flavonoid determination in plant extracts, while also noting the importance of appropriate standard selection and interference control3. The use of quercetin as a reference standard in this study is well-established in the literature; Ramadhani et

al and Haresmita and Pradani both validated quercetin-based calibration curves for flavonoid quantification in natural products, demonstrating good reproducibility and accuracy[22,23]. The consistent absorbance values across three replicates in this study further validate the precision of the analytical approach. These methodological strengths support the credibility and reproducibility of the findings reported here.

CONCLUSION

This study demonstrated that ethanol is a more effective solvent than ethyl acetate for extracting total flavonoids from melinjo peel (*Gnetum gnemon* L.) using the maceration method, yielding 51.86 mg QE/g compared to 46.05 mg QE/g, a difference attributable to ethanol's superior polarity and capacity to solubilize polar flavonoid glycosides. Phytochemical screening confirmed the presence of flavonoids, alkaloids, saponins, and tannins, while TLC analysis corroborated flavonoid identity through close Rf correspondence with quercetin. UV-Vis spectrophotometry with AlCl3 complexation proved to be a reliable and reproducible quantification method, supported by high-linearity calibration curves. These findings establish melinjo pericarp as a high-yield natural source of bioactive flavonoids with potential applications in the food, pharmaceutical, and cosmetic industries.

Future research is recommended to explore fractionation of the ethanol extract to isolate and characterize individual flavonoid compounds, as well as to evaluate their specific biological activities such as antioxidant, anti-inflammatory, and antimicrobial potency. Studies employing advanced extraction techniques such as ultrasound-assisted extraction, deep eutectic solvents, or supercritical fluid extraction may further optimize flavonoid recovery. Additionally, in vivo bioavailability studies and toxicological assessments are warranted prior to the development of melinjo peel-based formulations for commercial application.

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REFERENCES

1. Pratama AG, Bahri S, Herdini. ANTIBACTERIAL ACTIVITY TEST OF N-HEXANE AND ETHANOL EXTRACT OF MELINJO PEEL (GNETUM GNEMON L.) AGAINST SHIGELLA DYSENTERIAE AND BACILLUS CEREUS. *Journal of Research in Pharmacy and Pharmaceutical Sciences*. 2023;2(1):1-6. doi:10.33533/jrpps.v2i1.6598
2. Ben-Othman S, Jõudu I, Bhat R. Bioactives from agri-food wastes: Present insights and future challenges. *Molecules*. *MDPI AG*. 2020;25(3). doi:10.3390/molecules25030510
3. Shraim AM, Ahmed TA, Rahman MM, Hijji YM. Determination of total flavonoid content by aluminum chloride assay: A critical evaluation. *LWT*. 2021;150. doi:10.1016/j.lwt.2021.111932
4. Rudrapal M, Khairnar SJ, Khan J, et al. Dietary Polyphenols and Their Role in Oxidative Stress-Induced Human Diseases: Insights Into Protective Effects, Antioxidant Potentials and Mechanism(s) of Action. *Front Pharmacol*. *Frontiers Media S.A.* 2022;13. doi:10.3389/fphar.2022.806470

5. Nawaz H, Shad MA, Rehman N, Andaleeb H, Ullah N. Effect of solvent polarity on extraction yield and antioxidant properties of phytochemicals from bean (Phaseolus vulgaris) seeds. *Brazilian Journal of Pharmaceutical Sciences*. 2020;56. doi:10.1590/s2175-97902019000417129
6. Sebbah T, Yahla I, Cunha E, et al. Enhanced Extraction and Separation with HPLC-DAD of Phenolic and Flavonoid Antioxidants from Portulaca oleracea L. Leaves Using Tailored Terpenoid-Based NADES: Comparative Assessment of Antiradical and Antimicrobial Activities. *Antioxidants*. 2025;14(2). doi:10.3390/antiox14020132
7. Parhusip AJN, Angel V, Anugrahati NA, Honga J, Sinaga WSL. *Ethyl Acetate Extract of Red Melinjo (Gnetum Gnemon L.) Peel as Antibacterial Compound*. 2020.
8. Khan J, Asaf S, Lubna, Abdelbacki AMM, Jan R, Kim KM. Green Extraction of Antioxidant-Rich Flavonoids from Fagonia cretica Using Deep Eutectic Solvents. *Molecules*. 2025;30(4). doi:10.3390/molecules30040813
9. Widiyana AP, Illian DN. PHYTOCHEMICAL ANALYSIS AND TOTAL FLAVONOID CONTENT ON ETHANOL AND ETHYL ACETATE EXTRACT FROM NEEM (AZADIRACHTA INDICA JUSS.) LEAVES UTILIZING UV–VIS SPECTROPHOTOMETRIC. *Jurnal Farmasi Sains dan Praktis*. Published online April 29, 2022:71-77. doi:10.31603/pharmacy.v8i1.6582
10. Kozhantayeva A, Tursynova N, Kolpek A, et al. Phytochemical Profiling, Antioxidant and Antimicrobial Potentials of Ethanol and Ethyl Acetate Extracts of Chamaenerion latifolium L. *Pharmaceuticals*. 2024;17(8). doi:10.3390/ph17080996
11. Alqahtani A, Alqahtani T, Al Fatease A, Tolba EH. Rapid UV-Vis spectrophotometric method aided by firefly-PLS models for the simultaneous quantification of ciprofloxacin, lomefloxacin, and enrofloxacin in their laboratory mixture, dosage forms and water samples: greenness and blueness assessment. *BMC Chem*. 2024;18(1). doi:10.1186/s13065-024-01286-0
12. Madhu Vishwakarma, Ankit Kumar Srivastava, Alok Kumar, Arnab Roy. SECONDARY METABOLITE SCREENING OF Marsilea minuta L. FOR ALKALOID CONTENT: VALIDATION THROUGH TRIPLE CHROMOGENIC PRECIPITATION TECHNIQUES. *EPRA International Journal of Research & Development (IJRD)*. Published online June 1, 2025:622-629. doi:10.36713/epra22077
13. Palaiogiannis D, Chatzimitakos T, Athanasiadis V, Bozinou E, Makris DP, Lalas SI. Successive Solvent Extraction of Polyphenols and Flavonoids from Cistus creticus L. Leaves. *Oxygen*. 2023;3(3):274-286. doi:10.3390/oxygen3030018
14. Baharyati D, Wirasutisna KR, Hartati R. UJI AKTIVITAS ANTIOKSIDAN DAUN BIOLA (Ficus Lyrata Warb.). *Jurnal Farmagazine*. 2022;9(1):55. doi:10.47653/farm.v9i1.553
15. Luhulima AM, Martha A, Stikes L, et al. Formulasi dan Uji Sifat Fisik Sediaan Krim Ekstrak Etanol Buah Pala (Myristica Fragrans) Sebagai Anti Aging. *Jurnal Kesehatan Amanah*. 2021;5(2).
16. Hasnat H, Shompa SA, Islam MdM, et al. Flavonoids: A treasure house of prospective pharmacological potentials. *Heliyon*. 2024;10(6):e27533. doi:10.1016/j.heliyon.2024.e27533
17. Armadany FI, Musnina WOS, Wilda U. Formulasi dan Uji Stabilitas Lotion Antioksidan dari Ekstrak Etanol Rambut Jagung (Zea mays L.) sebagai Antioksidan dan Tabir Surya. *Pharmauho:Jurnal Farmasi, Sains, dan Kesehatan*. 2019;5(1). doi:10.33772/pharmauho.v5i1.8996
18. Hidayati R, Sari DEM, Noor N. Formulasi Sediaan Krim Ekstrak Wortel (Daucus carotaL.) dan Uji Aktivitasnya sebagai Tabir Surya secara In Vitro. *Jurnal Farmasi Sains dan Terapan*. 2023;10(1):25-31. doi:10.33508/jfst.v10i1.4467
19. Karim N, Arisanty, Rante Pakadang S. FORMULASI DAN UJI STABILITAS SEDIAAN LOTION EKSTRAK AIR BUAH TOMAT (Solanum lycopersicum L.). *Jurnal Kefarmasian Akfarindo*. Published online September 30, 2022:100-107. doi:10.37089/jofar.vi0.142
20. Damayanti RH, Meylina L, Rusli R. Formulasi Sediaan Lotion Tabir Surya Ekstrak Daun Cempedak (Artocarpus champeden Spreng). *Proceeding of Mulawarman Pharmaceuticals Conferences*. 2017;6:167-172. doi:10.25026/mpc.v6i1.279
21. Aminah A, Tomayahu N, Abidin Z. PENETAPAN KADAR FLAVONOID TOTAL EKSTRAK ETANOL KULIT BUAH ALPUKAT (Persea americana Mill.) DENGAN METODE SPEKTROFOTOMETRI UV-VIS. *Jurnal Fitofarmaka Indonesia*. 2017;4(2):226-230. doi:10.33096/jffi.v4i2.265
22. Ramadhani N, Samudra AG, Pratiwi LWI. Analisis Penetapan Kadar Flavonoid Sari Jeruk Kalamansi (Citrofortunella microcarpa) Dengan Metode Spektrofotometri UV-VIS. *Jurnal Mandala Pharmacon Indonesia*. 2020;6(01):53-58. doi:10.35311/jmpi.v6i01.57
23. Haresmita PP, Pradani MPK. DETERMINATION OF TOTAL FLAVONOID IN JAMU "X" WITH UV-VISIBLE SPECTROPHOTOMETRIC METHODS. *Jurnal Farmasi Sains dan Praktis*. Published online June 30, 2022:177-184. doi:10.31603/pharmacy.v8i2.6864
24. Hayat J, Akodad M, Moumen A, et al. Phytochemical screening, polyphenols, flavonoids and tannin content, antioxidant activities and FTIR characterization of Marrubium vulgare L. from 2 different localities of Northeast of Morocco. *Heliyon*. 2020;6(11):e05609. doi:10.1016/j.heliyon.2020.e05609