

Analysis of Bioactive Compounds in Functional Groups of *Morinda Citrifolia* Leaf Extract (*Morinda Citrifolia* L.) and Pearl Grass (*Hedyotis Corymbosa* L.) Using FTIR (Fourier Transform Infrared) Spectrophotometer as Antioxidants against Kidney Cell Damage Caused by Kidney Failure

Anggik Eka Nurmansyah¹, Safira Cahya Puspita², Irul Hidayat³, Eva Agustina⁴, Nova Lusiana⁵, Risa Purnamasari⁶, Funsu Andiarna⁷

¹²³⁴⁶Fakultas Sains dan Teknologi, UIN Sunan Ampel Surabaya

⁵⁷Fakultas Psikologi dan Kesehatan, UIN Sunan Ampel Surabaya

irul_hidayati@uinsa.ac.id

Keywords: *Kidney Failure, Bioactive Compounds, FTIR (Fourier Transform Infrared), Morinda Leaf, Pearl Grass*

Abstract: Kidney failure is a non-communicable disease that can be life-threatening. One plant that is often used as herbal medicine is noni leaf and pearl grass because they contain bioactive compounds. The purpose of this study was to analyze the differences in functional groups found in noni leaf and pearl grass extracts as antioxidants against kidney cell damage caused by kidney failure. Leaf extraction was performed using the maceration method with 70% ethanol as the solvent. Phytochemical testing was conducted qualitatively and also involved a literature review to determine the effects of bioactive compounds. The results of the pearl grass extract test showed strong peaks at wavelengths of approximately 3291 cm⁻¹ (O–H group), 1637 cm⁻¹ (aromatic C=C group), and 1034 cm⁻¹ (C–O alcohol group), indicating the presence of phenolic and flavonoid compounds. The FTIR spectrum results on noni leaves showed peaks at 3278 cm⁻¹ (O–H/N–H), 1630 cm⁻¹ (C=O/aromatic C=C), and 1052 cm⁻¹ (C–O), indicating the presence of carboxylic acid compounds, amines, and phenolic components. The functional groups of these compounds have significant potential to repair kidney cell damage caused by kidney failure. Based on the FTIR analysis results and supporting literature, it can be concluded that noni leaves are more effective than pearl grass in reducing kidney cell damage caused by kidney failure.

1 INTRODUCTION

The Kidney failure is a non-communicable disease that can be life-threatening. One plant that is often used as herbal medicine is noni leaf and pearl grass because they contain bioactive compounds. The purpose of this study was to analyze the differences in functional groups found in noni leaf and pearl grass extracts as antioxidants against kidney cell damage

caused by kidney failure. Leaf extraction was performed using the maceration method with 70% ethanol as the solvent. Phytochemical testing was conducted qualitatively and also involved a literature review to determine the effects of bioactive compounds. The results of the pearl grass extract test showed strong peaks at wavelengths of approximately 3291 cm⁻¹ (O–H group), 1637 cm⁻¹ (aromatic C=C group), and 1034 cm⁻¹ (C–O alcohol

group), indicating the presence of phenolic and flavonoid compounds. The FTIR spectrum results for noni leaves showed peaks at 3278 cm^{-1} (O–H/N–H), 1630 cm^{-1} (C=O/aromatic C=C), and 1052 cm^{-1} (C O), indicating the presence of carboxylic acid compounds, amines, and phenolic components. The functional groups of these compounds have significant potential to repair kidney cell damage caused by kidney failure. Based on the FTIR analysis results and supporting literature, it can be concluded that noni leaves are more effective than pearl grass in reducing kidney cell damage caused by kidney failure.

According to WHO data, chronic kidney disease is one of the global health problems with a mortality rate of 850,000 lives each year. This disease ranks 12th as a cause of death and 17th as a cause of disability worldwide. The mortality rate due to chronic kidney failure continues to show an increase, including in developing countries such as Indonesia. Based on doctors' diagnoses, the prevalence of chronic kidney failure in Indonesia is recorded at 0.2%. The highest rate is in Central Sulawesi at 0.5%, followed by Aceh, Gorontalo, and North Sulawesi at 0.4% each, while South Sulawesi has a prevalence of 0.3% (WHO, 2020).

Kidney failure can be treated with chemical drugs. Some commonly used drugs are antihypertensives, such as kalitake, aminoral, amlodipine, and telmisartan. However, the use of these chemical drugs often causes side effects in kidney failure patients, such as anemia, hypoglycemia, and edema. To reduce these negative effects, some people prefer to switch to natural ingredients as an alternative. Natural therapy is generally carried out through traditional methods

using herbal plants that prevent and help cure diseases (Rahman et al., 2023). One plant known to be beneficial in treating hypertension symptoms is mangosteen leaves (*Centella asiatica*) and turmeric (*Curcuma longa*).

Moringa leaves are known to contain various phytochemical compounds, including phenolic acids, flavonoids, alkaloids, and polysaccharides. These compounds provide various benefits, such as helping to treat hypertension and diabetes, as well as acting as antioxidants (Ramayani et al., 2021). Research by Rohman et al. (2006) shows that the antioxidant activity in noni leaves is greatly influenced by their phenolic and flavonoid content. The results of noni leaf extraction using the maceration method showed that the phenolic content reached 3.02% w/w GAE (Gallic Acid Equivalent), while the flavonoid content was recorded at 0.46% w/w QE (Quercetin Equivalent) (Ramayani et al., 2021). Wigati (2015) also confirmed that noni leaves have the potential to be used as a natural antihypertensive therapy because they are rich in bioactive compounds, particularly phenolics, with rutin and scopoletin as the main markers.

Based on a number of previous studies, both noni leaf extract and pearl grass extract are effective as antihypertensive agents that can lower blood pressure. This mechanism is important because an increase in blood pressure can trigger narrowing of the renal blood vessels, thereby risking damage to kidney cells and reducing their function, which can lead to kidney failure. Each plant has its own mechanism in affecting blood pressure and the body's immune system. Although existing research results have shown positive potential, further studies are still needed to understand the molecular mechanism in

detail and determine the optimal dosage in utilizing plant extracts as antihypertensive agents. Based on this, this study aims to identify bioactive compounds and their functional groups and analyze the effects of noni leaf extract (*Morinda citrifolia* L.) and pearl grass (*Hedyotis corymbosa* L.) using the Fourier Transform Infrared (FTIR) Spectrophotometer method in an effort to prevent kidney cell damage due to kidney failure.

2 METHOD

Tools and Materials

This research was conducted at the Basic Chemistry Laboratory of Sunan Ampel State Islamic University in Surabaya. Some of the equipment used in this research included a UV-Vis spectrophotometer, cuvettes, measuring pipettes, measuring cups, reaction tubes, Erlenmeyer flasks, Falcon tubes, beaker glasses, vortexes, centrifuges, drying ovens, analytical scales, rotary evaporators, as well as Fourier Transform Infrared (FTIR) and High Performance Liquid Chromatography (HPLC) devices. Meanwhile, the materials used included noni leaf powder, pearl grass, p.a methanol solution, 70% ethanol, distilled water, hydrochloric acid (HCl), sulfuric acid (H₂SO₄), acetic acid, chloroform (CHCl₃), sodium carbonate (NaCO₃), Folin Ciocalteu reagent, Dragendorff reagent, Liebermann Burchard reagent, magnesium, FeCl₃, Mayer Wagner, NaOH, DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (3-ethylbenzothiazoline-6-sulfonic acid), TPTZ (2,4,6-tripyridyl-s-triazine), ferrous sulfate, as well as gallic acid, quercetin, and Trolox standards.

Research Procedure

- **Leaf Extraction Process**

Extraction of noni leaves (*Morinda citrifolia* L.) and pearl grass (*Hedyotis Corymbose* L.) was carried out using the maceration method with 70% ethanol solvent. The extraction process was carried out by first separating the leaves from the stems, then washing them with running water until clean. The leaves were cut into small pieces to speed up the drying process, either under the sun or using a drying oven. Once dry, the leaves were ground into a fine powder. A total of 250 grams of leaf powder was then weighed and placed in a sealed glass container. Next, 1,250 ml of distilled water is added, stirred until homogeneous, then left to stand for 2×24 hours with periodic stirring. The resulting maserate is filtered and squeezed using filter paper to obtain a liquid extract. The extraction process continued with the decoction of the leaf residue, which involved boiling the remaining extract solids using 70% ethanol solvent until boiling, with the aim of extracting the remaining compounds. The resulting macerate was evaporated until only the pure leaf extract remained, which could then be used for phytochemical testing.

- **Phytochemical Test**

Phytochemical testing of noni leaves (*Morinda citrifolia* L.) and pearl grass (*Hedyotis Corymbose* L.) extracts was conducted using various reagents to determine the presence of secondary metabolites, such as alkaloids,

flavonoids, phenolics, tannins, saponins, steroids, and triterpenoids.

a. Alkaloid

Alkaloid compounds were identified by adding 1% HCl and Dragendorff's reagent to 0.5 grams of extract, where the formation of a precipitate indicated a positive result.

b. Flavonoids

After that, testing for flavonoid compounds is continued by dissolving 0.2 grams of extract in ethanol, then heating it for 5 minutes, adding concentrated HCl and magnesium powder. The appearance of a blackish red color indicates the presence of flavonoids.

c. Phenolics

Phenolic compounds were tested by dissolving 0.5 grams of extract in 70% ethanol, then adding 5% FeCl₃ solution, and a positive result was indicated by the appearance of a blackish green color.

d. Tannin

Tannins are tested by reacting 0.5 grams of extract solution in 70% ethanol solvent, then adding 5% FeCl₃ solution, and a positive result is indicated by a blue-green color change.

e. Saponins

The presence of saponin compounds is determined through a foam test, which involves dissolving the extract in hot distilled water, then adding 2N HCl, and stirring until a stable foam forms.

f. Steroids and Triterpenoids

The testing of both steroid and triterpenoid compounds is carried out by reacting the extract with CHCl₃, acetic acid, and concentrated H₂SO₄, where a reddish-brown color change

indicates the presence of steroids. Meanwhile, the formation of a red ring indicates the presence of triterpenoid compounds.

- **Uji Fourier Transform Infrared (FTIR)**

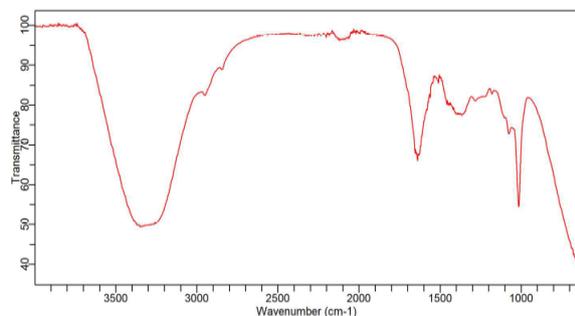
- a. Turn on the FTIR testing device and the computer connected to the software used for analysis.
- b. Place the sample in the sample holder.
- c. Operate the FTIR device to produce an FTIR spectrum of the sample.
- d. Read the FTIR spectrum by comparing it with the FTIR table.

- **Literature Review**

Literature review is a study of literature that is developed in stages as follows: identifying themes, identifying methods, establishing journal criteria, searching for and selecting research journals, summarizing results, and presenting the review. The literature search technique used was Google Scholar with the keywords herbal plants and hypertension. The journal criteria in this study were journals published between 2019 and 2025; using Indonesian; journals containing research on herbal plants and compounds that can treat hypertension. The journal search was adjusted to the inclusion and exclusion criteria, then continued by reading the entire article.

3 RESULT AND DISCUSSION

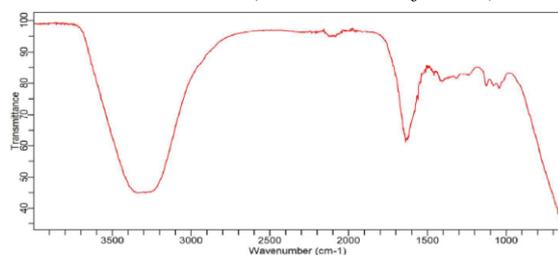
Table 1 FTIR spectrum results of pearl grass extract (*Hedyotis Corymbosa* L.).



Peak Number	Wavenumber (cm ⁻¹)	Intensity
1	1015,69956	0,26276
2	1075,33697	0,55603
3	1280,34055	0,68823
4	1638,16498	0,44743
5	1999,71675	0,96042
6	2120,85523	0,93009
7	2202,85666	0,94295
8	2845,82244	0,81314
9	3350,87672	0,18067

The results of the pearl grass extract test showed strong peaks at wavelengths of approximately 3291 cm⁻¹ (O–H group), 1637 cm⁻¹ (aromatic C=C group), and 1034 cm⁻¹ (alcohol C–O group), indicating the presence of phenolic and flavonoid compounds.

Table 2 FTIR spectrum results of morinda citrifolia leaf extract (*Morinda Citrifolia* L.)



Peak Number	Wavenumber (cm ⁻¹)	Intensity
1	1045,51826	0,66643
2	1082,79164	0,67941
3	1125,65603	0,67971
4	1313,88659	0,71545
5	1638,16498	0,39447
6	2107,80955	0,92658
7	3335,96736	0,13642

The FTIR spectrum results of noni leaves show peaks at 3278 cm⁻¹ (O–H/N–H), 1630 cm⁻¹ (C=O/aromatic C=C), and 1052 cm⁻¹ (C–O), indicating the presence of carboxylic acid compounds, amines, and phenolic components. The functional groups of these compounds, especially flavonoids, have significant potential to repair kidney cell damage caused by kidney failure. In addition, phenolic compounds, carboxylic acids, and amines play a role in antimicrobial, anti-inflammatory, and anti-infective properties, as well as helping to repair kidney cell damage.

The presence of bioactive compounds with antioxidant and anti-inflammatory activities is very important for suppressing oxidative stress and excessive inflammatory responses. In this study, noni leaves (*Morinda citrifolia*) and pearl grass (*Hedyotis corymbosa*) were used as sources of natural active compounds. Both the fruit and leaves of the noni plant are used as traditional medicine (Wijayanti & Qomariyah, 2023). Noni leaves (*Morinda citrifolia*) contain various bioactive compounds that play an important role in protecting and repairing kidney cell damage. Research by Wigati & Pratoko (2016) states that the high antioxidant activity in noni leaves is partly due to the higher flavonoid content in noni leaves compared to noni fruit.

Pearl grass (*Hedyotis corymbosa*) is a plant that can be used as a traditional medicine because it is affordable and easily available. Pearl grass

(*Hedyotis corymbosa*) contains natural active compounds, namely flavonoids. The flavonoid content in this plant provides antioxidant and anti-inflammatory activities (Wiyanti *et al.*, 2023).

The main flavonoids contained in noni leaves include rutin and quercetin. The antioxidant mechanism of the flavonoid quercetin is explained by Rice-Evans. The structure of quercetin and rutin (quercetin-3-O-rutinoside) shows an important role in determining the antioxidant potential of flavonoids. The dihydroxy ring B plays the most important role in donating hydrogen (electrons) to stabilize radical compounds. The presence of a conjugated 2,3-unsaturated group on 4-oxo in ring C is capable of binding transition metal ions (Sang *et al.*, 2001; Rice-Evans, 1996; Wigati & Pratoko, 2016).

The mechanism of healing kidney cell damage caused by kidney failure through the bioactive content in both morinda citrifolia leaf extract and *Hedyotis corymbosa* extract is mainly related to antioxidant and anti-inflammatory activities. Antioxidant activity works through a cell defense pathway controlled by the transcription factor Nrf2 (nuclear factor erythroid 2-related factor 2). Under normal conditions, Nrf2 is inhibited by Keap1 (Kelch ECH associating protein 1) so that it degrades quickly. However, when oxidative stress occurs, the bond between Nrf2 and Keap1 is released, causing Nrf2 to accumulate in the cytoplasm and then move to the cell nucleus to activate gene expression that depends on the antioxidant responsive element (ARE) (Perdhana & Suzana, 2019). As a result, cells can increase the production of endogenous antioxidant enzymes that play a role in fighting free radicals.

Anti-inflammatory activity is related to the regulation of the NF- κ B (nuclear factor kappa B)

pathway. Under normal conditions, NF- κ B is bound to I κ B (Inhibitor of κ B) in the cytoplasm, rendering it inactive. When oxidative stress, infection, or inflammation occurs, I κ B undergoes degradation due to phosphorylation by the IKK (I κ B kinase) enzyme. The released NF- κ B then moves to the cell nucleus and induces the transcription of proinflammatory genes (Rahmawati, 2024). Thus, an increase in anti-inflammatory bioactive compounds can inhibit NF- κ B activation, thereby reducing inflammation and kidney tissue damage.

Flavonoids, as secondary metabolites, play an important role not only as antioxidants but also as anti-inflammatory agents. The antioxidant activity of flavonoids occurs through their ability to donate electrons or hydrogen atoms to stabilize free radicals, thereby preventing further oxidative damage (Ahmad & Ibrahim, 2015). According to previous studies, flavonoids play a role in suppressing the activation of the NF- κ B pathway in cells, which results in reduced secretion of inflammatory mediators including IL-6, IL-1, TNF- α , and CRP (Mujayanto *et al.*, 2020). It is this combination of antioxidant and anti-inflammatory effects that makes flavonoids highly effective in reducing kidney cell damage due to kidney failure.

Various previous studies have shown that herbal plants have therapeutic potential and contain bioactive compounds that can lower blood pressure and repair kidney damage. The study by Putri *et al.*, (2023) discusses the effectiveness of star fruit leaf tea in lowering blood pressure in patients with hypertension. This systematic literature review study selected journals from Google Scholar based on specific criteria, which were then analyzed to examine the role of herbal plants in controlling

hypertension. The results showed that consumption of starfruit leaf tea was able to reduce systolic blood pressure by 20.06 mmHg and diastolic blood pressure by 17.50 mmHg, with an average post-treatment blood pressure of 134.06/75.00 mmHg. These effects are related to the flavonoid, potassium, and vitamin C content, which play a role in lowering blood pressure.

Furthermore, Andika *et al.*, (2023) conducted in vivo tests to assess the effectiveness of matoa leaf extracts and fractions on antihypertensive and antihypercholesterolemic activities. The extracts were obtained through 70% ethanol maceration and then fractionated with n-hexane, ethyl acetate, and 96% ethanol solvents. The results showed that administration of matoa leaf extract at a dose of 300 mg/kgBW was effective in lowering cholesterol levels, while matoa leaf fractions had a significant effect on lowering blood pressure. These antihypertensive and antihypercholesterolemic effects were dose-dependent, where an increase in dose was directly proportional to an increase in the effect of lowering blood pressure and cholesterol.

A literature review conducted by Murtini & Setyawan (2023) discussed the antioxidant activity of morinda leaves and fruit (*Morinda citrifolia* L.). Based on phytochemical screening results, this plant contains flavonoid compounds known to have antioxidant properties. Antioxidant activity tests showed that noni leaves had an IC₅₀ value of 49.09 µg/mL, while noni fruit had an IC₅₀ value of 22.95 µg/mL. Both values are classified as very strong, indicating a significant ability to neutralize free radicals. In vivo research was also conducted by Parawansa (2023) on the protective effects of Java wood bark extract (*Lannea coromandelica*) on the kidneys of male Wistar rats induced with

monosodium glutamate (MSG). The extract was administered for 28 days, followed by measurements of urea, creatinine, and MDA levels, as well as histopathological examination of the kidneys. The results showed an improvement in biochemical and histological parameters of the kidneys after administration of the extract. This protective effect is associated with the content of secondary metabolites such as flavonoids, triterpenoids, tannins, phenolics, saponins, and steroids, which have antioxidant, anti-inflammatory, antibacterial, and immunomodulatory activities.

Furthermore, Pratama *et al.*, (2022) assessed the effect of green tea (*Camellia sinensis*) consumption on blood pressure reduction in hypertensive patients through a pre-test and post-test quasi-experimental design. A total of 10 respondents participated in this study, and statistical analysis showed a significant effect with a p-value of 0.01 ($p < 0.05$). These findings support the hypothesis that green tea consumption contributes to lowering blood pressure. In addition, Azizah *et al.*, (2019) studied the effects of ethanol extract of African leaves (*Vernonia amygdalina* Delile) on male white rats induced with gentamicin as a nephrotoxic model. The extract was administered orally for 14 days at doses of 100, 250, and 500 mg/kgBW. The results showed that a dose of 500 mg/kgBW provided the most optimal nephrotherapeutic effect in reducing urea levels. This indicates that the flavonoid content in African leaves plays an important role through its antioxidant mechanism.

In line with these findings, Fauzan *et al.*, (2025), through a narrative literature review, stated that plant extracts containing flavonoids, phenols, alkaloids, tannins, and saponins have the potential to

repair kidney damage in diabetic rats. This repair mechanism occurs through antioxidant activity that can reduce oxidative damage to renal tubule cells, thereby improving the histopathological condition of the kidneys. Research by Anas and Hatimah evaluated the antihypertensive effects of a combination of corn (*Zea mays* L.) hair and seed ethanol extract on MSG-induced hypertensive rats. Administration of the extract at a dose of 500 mg/kgBW/day was shown to reduce systolic blood pressure by 20.04 mmHg and diastolic blood pressure by 13.16 mmHg. These results indicate that the combination of corn silk and corn kernel extracts is effective as a natural antihypertensive agent.

Research conducted by Anzelita *et al.*, (2025) focused on the protective effects of black cumin (*Nigella sativa* L.) extract against kidney damage in white rats (*Rattus norvegicus*) induced by tetracycline. A total of 25 male Wistar rats were divided into five treatment groups, consisting of a positive control, a negative control that was only given 200 mg/kgBW of tetracycline, and three treatment groups that each received 200 mg/kgBW of tetracycline and black cumin extract at doses of 200 mg/kgBW, 400 mg/kgBW, and 800 mg/kgBW. The treatment was administered for 14 consecutive days. The results showed that black cumin extract was able to reduce creatinine levels and improve the histopathological picture of kidneys damaged by tetracycline induction. This proves that black cumin has nephroprotective activity related to its bioactive compounds, especially those with antioxidant properties.

The latest study conducted by Anselia *et al.*, 2025, aimed to evaluate the nephroprotective effects of red ginger ethanol extract on white rats induced

with ethylene glycol to cause kidney damage. A total of 25 rats were used and divided into five treatment groups, namely a normal control group with distilled water, a negative control group with ethylene glycol, and three treatment groups, each given a combination of ethylene glycol and red ginger extract at different doses, namely 100, 200, and 300 mg/kgBW per day. Observations were made by measuring serum creatinine levels and assessing renal histopathology to determine improvements in function and tissue structure. The results showed that red ginger extract significantly reduced serum creatinine levels, with the 300 mg/kgBW dose showing the highest reduction and improvements in histopathology, including reduced necrosis, cell degeneration, and inflammatory cell infiltration. Thus, it can be concluded that red ginger ethanol extract has a significant nephroprotective effect, characterized by improved kidney function and protection against kidney tissue damage.

Based on the description of these various studies, it can be concluded that the use of herbal plants has great potential in the field of health, particularly as antihypertensive and nephroprotective agents. Plants such as star fruit, matoa, mengkudu, Javanese wood, green tea, African leaves, corn, black cumin, and rosella have been proven to contain bioactive compounds such as flavonoids, alkaloids, tannins, saponins, and vitamins that play an important role in antioxidant and anti-inflammatory mechanisms. The activity of these compounds not only contributes to lowering blood pressure but also protects the kidneys from oxidative damage caused by exposure to drugs or toxic substances. These research findings highlight the potential for developing safer, more affordable herbal-based

complementary therapies that could support conventional treatments. However, further research with controlled clinical designs is needed to confirm their efficacy, optimal dosage, and safety for human use.

4 CONCLUSIONS

The results of the study show that extracts of noni leaves (*Morinda citrifolia*) and pearl grass (*Hedyotis corymbosa*) both contain bioactive compounds with antioxidant and anti-inflammatory activities that play an important role in repairing kidney cell damage caused by kidney failure. Pearl grass is known to contain phenolic compounds and flavonoids that function to suppress oxidative stress and inflammatory responses. Meanwhile, noni leaves contain the main flavonoids rutin and quercetin, as well as additional compounds such as phenolics, carboxylic acids, and amines that have a stronger ability to protect kidney tissue from damage through antioxidant and anti-inflammatory mechanisms.

Based on FTIR analysis results and supporting literature reviews, it can be concluded that noni leaves are more effective than pearl grass in reducing kidney cell damage caused by kidney failure. This effectiveness is supported by the higher flavonoid content in noni leaves with stronger antioxidant potential, coupled with the presence of other bioactive compounds that act as anti-inflammatory and antimicrobial agents. Therefore, noni leaves have greater potential as a natural nephroprotective agent compared to pearl grass.

5 REFERENCES

- Aga, M. S. A., Reong, A. R., Mane, G., Lukas, C. N. L. I. L., & Irianto, I. D. (2024). Gambaran Pasien Gagal Ginjal Kronik Yang Memiliki Riwayat Hipertensi Di Ruangan Hemodialisa. *Jurnal Keperawatan Jiwa*, 12(3), 691-698.
- Ahmad, I., & Ibrahim, A. (2015). Bioaktivitas Ekstrak Metanol Dan Fraksi N-Heksana Daun Sungkai (*Peronema Canescens* Jack) Terhadap Larva Udang (*Artemia Salina* Leach) Islamudin. *Jurnal Sains Dan Kesehatan*, 1(3), 114-119.
- Andika, M., Febriana, T. A., Nanda, N., Putra, F. A., & Fitriani, O. S. (2023). Uji Efektivitas Ekstrak Dan Fraksi Daun Matoa Terhadap Antihipertensi Dan Antihiperkolesterolemia Secara In Vivo. *Jops (Journal Of Pharmacy And Science)*, 7(1), 114-122.
- Annisaa, E., Anam, K., Sasikirana, W., Dianingati, R. S., & Wulandari, F. (2020). Buku Saku Jamu Hipertensi (E. Annisaa, Ed.). Semarang: Fakultas Kedokteran Universitas Diponegoro.
- Anselia, B., Lubis, A. A., & Sembiring, N. B. (2025). Efek Nefroprotektif Ekstrak Etanol Jahe Merah (*Zingiber Officinale* Var. Rubrum) Terhadap Gambaran Histopatologi Ginjal Tikus (*Rattus Norvegicus*) Yang Diinduksi Oleh Etilen Glikol. *Journal Of Pharmaceutical And Sciences*, 1612-1624.
- Anzelita, A., Lubis, A. A., & Yunus, M. (2025). Efek Protektif Ekstrak Jinten Hitam (*Nigella Sativa* L.) Terhadap Gambaran Histopatologi Ginjal Tikus Putih (*Rattus Norvegicus*) Yang Diinduksi Tetrasiklin. *Sciences And Clinical Pharmacy Research Journal*, 2(2), 11-11.

- Asriani, Bahar, B., Kadrianti Dan Erna. 2013. Hubungan Hipertensi Dengan Kejadian Gagal Ginjal Di Rumah Sakit Ibnu Sina Makassar Periode Januari 2011-Desember 2012. *Jurnal Ilmiah Kesehatan Diagnosis* 4(2).
- Azizah, R. N., Santi, I., & Marlian, A. (2019). Uji Nefroterapi Ekstrak Etanol Daun Afrika (*Vernonia Amygdalina Delile*) Dengan Parameter Ureum Tikus Putih Jantan Yang Diinduksi Gentamisin. *Window Of Health: Jurnal*
- Fauzan, M. A., Widayanti, E., & Royhan, A. (2025). Literature Review: Of The Effect Of Plant Extracts That Contain Alkaloids On The Histopathology Of Diabetic Rat Kidneys. *Junior Medical Journal*, 3(4), 492-507.
- Giena, V. P., Dari, D. W., & Keraman, B. (2018). Hubungan Hipertensi Dengan Stadium Gagal Ginjal Kronik Pada Pasien Dewasa Yang Berobat Di Unithemodialisa Rsud Dr. M. Yunus Bengkulu Tahun 2017. *CHMK Nursing Scientific Journal*, 2(1), 32-44.
- Mujayanto, R., Shafia, A., & Feranisa, A. (2020). Bay Leaf (*Syzygium Polyanthum*) Extract Effect On Il-10 Expression In Oral Ulcer. *Odonto : Dental Journal*, 7(1), 53.
- Murtini, N. K. A., & Setyawan, E. I. (2023, November). Aktivitas Antioksidan Alami Dari Daun Dan Buah Mengkudu (*Morinda Citrifolia L*) Sebagai Penangkal Radikal Bebas. In *Prosiding Workshop Dan Seminar Nasional Farmasi* (Vol. 2, Pp. 593-603).
- Naimi, A. H. (2018). *Efek Antihipertensi Ekstrak Etanol Kombinasi Rambut Dan Biji Jagung (Zea Mays L.) Pada Tikus Hipertensi Yang Diinduksi Monosodium Glutamat (Msg)* (Doctoral Dissertation, Universitas Wahid Hasyim Semarang).
- Oyenihi, A. B., Ayeleso, A. O., Mukwevho, E., & Masola, B. (2015). Antioxidant Strategies In The Management Of Diabetic Neuropathy. *Biomed Research International*, 2015(1), 515042.
- Parawansa, D. A. (2023). Efek Protektif Ekstrak Kulit Batang Kayu Jawa (*Lannea Corocomandelica*) Terhadap Kadar Mda, Ureum, Kreatinin, Dan Gambaran Histopatologi Ginjal Pada Tikus Wistar Jantan Yang Di Induksi Msg= Protective Effect Of Java Wood Bark Extract (*Lannea Corocomandelica*) On Mda, Ureum, Creatinine, And Kidney Histology In Msg-Induced Male Wistar Rats.
- Perdhana, I. S., & Suzana, D. (2019). Peran Kuersetin Terhadap Ekspresi Nrf2 Pada Stres Oksidatif Akibat Penyakit Ginjal Kronik. *Informatika Kedokteran: Jurnal Ilmiah*, 2(1), 27-36.
- Pratama, A. S., Praghlapati, A., & Nurrohman, I. (2020). Mekanisme Koping Pada Pasien Gagal Ginjal Kronik Yang Mep-Njalani Hemodialisis Di Unit Hemodialisa RSUD Bandung. *Jurnal Smart Keperawatan*, 7(1), 18. <https://doi.org/10.34310/jskp.v7i1.318>
- Pratama, A. W., Hafiduddin, M., & Sumaji, M. A. (2022). Pengaruh Pemberian Teh Hijau Terhadap Penurunan Tekanan Darah Pada Pasien Hipertensi. *Jurnal Kesehatan Dan Kedokteran*, 1(3), 93-98.
- Putri, M. A., Sudarmi, S., & Kuswanto, K. (2023). Efektivitas Teh Daun Belimbing Wuluh Terhadap Penurunan Tekanan Darah

- Penderita Hipertensi. *J Penelit Perawat Prof*, 5(1), 155-162.
- Rahman, L. H., Ratnasari, D., & Handayani, R. P. (2023). Analisis Uji Kesukaan Teh Herbal Akar Kayu Kuning (*Arcangelisia Flava* (L.) Merr) Dengan Penambahan Daun Stevia (*Stevia Rebaudiana*) Sebagai Pemanis Alami Untuk Memelihara Penderita Diabetes. *Journal Of Holistic And Health Sciences (Jurnal Ilmu Holistik Dan Kesehatan)*, 7(1), 17-21.
- Rahmawati, F. F. B. (2024). Pengaruh Pemberian *Exosome Xypoxia Mesenchymal Stem Cells Terhadap Ekspresi Gen NF-Kb (P65) Dan Enzim Catalase Pada Penuaan Kulit (Study Eksperimental In Vivo Pada Tikus Jantan Galur Wistar Yang Dipapar UV-B)* (Doctoral Dissertation, Universitas Islam Sultan Agung Semarang).
- Ramayani, S. L., Permatasari, E. A., Novitasari, I., & Maryana, M. (2021). Pengaruh Metode Ekstraksi Terhadap Kadar Total Fenolik, Kadar Total Flavonoid Dan Aktivitas Antioksidan Ekstrak Daun Mengkudu (*Morinda Citrifolia* L.). *Jurnal Ilmu Farmasi Dan Farmasi Klinik*, 18(01), 40-46.
- Rohman, A., Riyanto, S., & Utari, D. (2006). Antioxidant Activities, Total Phenolic And Flavonoid Contents Of Ethyl Acetate Extract Of Mengkudu (*Morinda Citrifolia* L.) Fruit And Its Fractions. *Majalah Farmasi Indonesia*, 17(3), 136-142.
- Wigati, D., & Pratoko, DK (2016). Total Flavonoid Dan Aktivitas Penangkapan Radikal Bebas Dari Ekstrak Etanolik Daun Dan Buah Mengkudu. *Jurnal Farmasi* , 5 (1), 348912.
- Wigati, D., 2015. Efek Ekstrak Etanolik Daun Dan Buah *Morinda Citrifolia* L. Terhadap Tekanan Darah Dan Gambaran Hispatologi Ginjal Tikus Hipertensi Terinduksi Deksametason. Tesis. Universitas Gajah Mada : Yogyakarta
- Wijayanti, AR, & Qomariyah, N. (2023). Pengaruh Ekstrak Daun Mengkudu (*Morinda Citrifolia* L.) Terhadap Kadar Hemoglobin Dan Histopatologi Hepar Mencit Diabetes. *Lenterabio: Berkala Ilmiah Biologi* , 12 (1), 14-24.
- Wiyanti, Z. O., Rusdiansyah, A. H., Susianti, S., & Oktarlina, R. Z. (2023). The Effect Of Ethanol Extract Of Pearl Grass (*Hedyotis Corymbosa* L.) On Liver Histopathology In White Rats (*Rattus Norvegicus*) Male Sprague Dawley Strain Induced By Rifampicin And Isoniazid. *Medical Profession Journal Of Lampung*, 13(3), 379-386.
- World Health Organization. (2020). The World Health Organization: Global kidney disease report