

# Analysis of Total Phenolic Content Of Moringa Oleifera Leaf Extract Using Uv-Vis Spectrophotometer

Marisa<sup>1</sup>, Ines Puspita Sari<sup>2</sup>, Avitra Nawang Sari<sup>3</sup>, Ilma Salsabilla Hidayah<sup>4</sup>, Fitri A<sup>5</sup>, Ria Qadariah Arief<sup>6</sup>, Romyun Alvy Khoiriyah<sup>7</sup>, Funsu Andiarna<sup>8</sup>, Irul Hidayati<sup>9</sup>, Eva Agustina<sup>10</sup>

<sup>10</sup>Fakultas Sains dan Teknologi, UIN Sunan Ampel Surabaya

<sup>123456789</sup>Fakultas Psikologi dan Kesehatan, UIN Sunan Ampel Surabaya

[risamarisa2304@gmail.com](mailto:risamarisa2304@gmail.com)

**Keywords:** *Phenolic, Maceration, Moringa Leaves, UV-Vis Spectrophotometer*

**Abstract:** Background: Moringa leaves (*Moringa oleifera*) are known to contain phenolic compounds that act as antioxidants, which can help reduce free radical activity and potentially provide health benefits. Objective: This study aimed to determine the total phenolic content of moringa leaf extract. Methods: Moringa leaf extract was prepared by maceration using methanol as the solvent, and the total phenolic content was determined using a UV-Vis spectrophotometer with gallic acid as the standard. Results: Based on the absorbance measurement at a wavelength of 764 nm, the moringa leaves had a concentration of 188.9 mg/L and a total phenolic content of 18.89 mg GAE/g. Conclusion: Based on this research, the extract of moringa leaves contains phenolic compounds, so it has the potential to act as an antioxidant and is beneficial for health.

## 1 INTRODUCTION

Free radicals are highly reactive molecules because they have one or more unpaired electrons, making them susceptible to oxidative reactions with other molecules. Free radicals can damage proteins, lipids, DNA, and cell membranes, leading to death, abnormalities, and various degenerative diseases such as cancer, diabetes, heart disease, and premature aging. This damage occurs due to excessive oxidation, which causes oxidative stress in cells and tissues (Janitra et al., 2025). Antioxidants play a crucial role in protecting the body from the harmful effects of free radicals by neutralizing them. Antioxidants donate electrons or hydrogen to free radicals, reducing their reactivity and protecting cell structures from oxidative damage. The body possesses an endogenous antioxidant system;

however, when free radicals are present in excess, exogenous antioxidants from food, supplements, or plants are required to support this protection. One important group of antioxidant compounds is phenolic compounds, which are secondary metabolites found in plants. Phenolic compounds such as flavonoids, tannins, gallic acid, and polyphenols play a significant role in antioxidant activity due to the ability of their hydroxyl groups to donate hydrogen atoms or electrons to free radicals, forming resonance-stabilized phenoxyl compounds. Furthermore, phenolic compounds can also bind free radicals, decompose oxidation products, and chelate metal ions that can potentially damage cells (Maharan et al., 2025).

Phenolic compounds, or polyphenols, are chemically composed of one or more phenolic rings and are a class of natural antioxidants important in

protecting cells from free radical damage by donating electrons or protons, chelating metals, and inhibiting the formation of new free radicals through electron transfer (Sedate et al., 2023). Phenolic compounds are found in many natural plants, for example, flavonoids, which are the largest group of phenolic compounds with strong antioxidant properties found in almost all plant species. Papaya leaves and plants from the Asteraceae family contain phenolic compounds that have antioxidant, anticancer, and anti-inflammatory roles (Wulandari et al., 2025).

One leaf that has been the subject of extensive research is the phenolic content of *Moringa oleifera* leaves. Recent research shows that the ethanol extract of *Moringa* leaves contains a higher total phenolic content than the stems, with the phenolic content of *Moringa* leaf extract reaching 19.513 mg GAE/g (Juni Asti & Sagala, 2021).

The *Moringa* (*Moringa Oleifera*) plant is widely known as the miracle tree because it has many benefits not only as a food ingredient but also as a traditional medicine. *Moringa* leaves are widely used in various regions for traditional medicine such as reducing hypertension, treating headaches, and so on due to their active compounds (Musyaropah & Cahyanto, 2025). *Moringa* leaves contain various secondary metabolites such as phenolic compounds, flavonoids, saponins, and alkaloids. These metabolites function in the biological activities of *Moringa* leaves such as antioxidants, antidiabetic, anti-inflammatory, and antimicrobial. Many recent studies have shown that *Moringa* leaves are rich in antioxidants that provide protection against free radicals. Methods for testing the amount of antioxidants in *Moringa* leaves such as DPPH, FRAP, and ABTS show that *Moringa* leaf extract has

antioxidant activity ranging from strong to very strong (Putri et al., 2024).

Research on *Moringa* leaves remains extensive, particularly regarding a comprehensive understanding of the complete profile of secondary metabolites from various plant parts and their relationship to their pharmacological benefits. Although numerous studies have identified the presence of phenolic compounds, flavonoids, saponins, and alkaloids, comprehensive information regarding the quantification and specific role of each compound in its biological activity remains limited (Khairi et al., 2025). In addition to leaves, other parts, such as seeds, also contain secondary metabolites that act as antioxidants. However, research into the composition and biological activity of metabolites in *Moringa* seeds remains insufficient. Many studies focus solely on leaves, while other parts receive less attention, necessitating further studies on the quantitative and qualitative content and benefits of other parts of *Moringa* (Dising, 2024). Furthermore, most studies still focus on the identification and general activity of antioxidants, while the molecular mechanisms of action of metabolites in *Moringa* related to disease prevention or therapy remain understudied. Therefore, further research is urgently needed to examine these mechanisms in detail (Salu et al., 2016).

The aim of this study was to determine the total phenolic content of the extract methanol *Moringa* leaves were analysed using a UV-Vis spectrophotometer with Folin-Ciocalteu reagent and gallic acid standard. Total phenolic content was determined by measuring the absorbance of the extract at a specific wavelength and comparing it with the gallic acid standard curve to obtain phenolic

values in units of mg equivalents of gallic acid per gram of sample. Furthermore, this study aims to provide scientific information regarding the potential of Moringa leaves as a source of natural antioxidants that are closely related to the levels of phenolic compounds. With this data, the scientific basis for the use of Moringa leaves as a functional food ingredient and natural medicine with significant antioxidant activity can be strengthened.

## 2 METHOD

### Materials and Tools

The equipment consists of an oven, chopper, digital mesh scale, analytical scale, stirring rod, 1000ml beaker glass, rotary evaporator, dropper pipette, measuring pipette, 100ml measuring flask, 10ml measuring flask, test tube and rack, vortex, centrifuge tube, centrifuge, UV-Vis spectrophotometer.

The ingredients consist of 100 grams of moringa leaf simplicial, 500ml of 70% methanol, folin-ciocalteu reagent, 7% Na<sub>2</sub>CO<sub>3</sub> solution, gallic acid, filter paper and aluminum foil.

### Research Stages

#### Making Moringa Leaf Simple

The moringa leaves are separated from the stems, washed thoroughly, and then air-dried until no water remains. The leaves are then oven-dried at a temperature of 40°C -50°C for 5 minutes until dry. Grind the dried leaves with a chopper until they form a powder. For a finer result, strain the leaves through a mesh sieve.

### Methanol Extraction of Moringa Leaves

A total of 100 grams of Moringa leaf powder was extracted using the maceration method using 500L of 70% methanol solvent (1:5). Maceration was carried out by dissolving Moringa leaf powder with methanol solvent made in a glass beaker container and an aluminum foil cover, then the container was placed in a place protected from sunlight for 3x24 hours at room temperature. The macerate results were then separated using filter paper. The liquid macerate results were then concentrated using a rotary evaporator at a temperature of 45°C. After all the solvents have separated, the extract is then weighed and the result is 10g.

### Yield Calculation

Based on the final results of weighing the extract mass after being concentrated to 10g, the percentage size of the product produced can be calculated as follows:

$$\begin{aligned} \% \text{ yield} &= \frac{\text{Extract mass}}{\text{Initial powder mass}} \times 100\% \\ &= \frac{10}{100} \times 100\% \\ &= 10\% \end{aligned}$$

In this case, it indicates that from 100 grams of moringa leaf powder extracted, 10 grams of concentrated extract was obtained. This value indicates that the extraction process produced a yield of 10%

### Addition of Reagents

A total of 0.01g of Moringa leaf extract was weighed, then methanol was added to a measuring flask up to 10ml and shaken until homogeneous. A total of 1 ml of the extract solution was taken and put

into a test tube with the addition of 0.5ml of Folin Ciocalteu reagent, then shaken and left for 8 minutes. After that, 4ml of 7% Sodium Carbonate solution was added, then vortexed until homogeneous. The solution was transferred into a centrifuge tube and then centrifuged for 5 minutes at a speed of 4.4 rpm. The centrifuged solution was separated from the sediment. The resulting solution without sediment was then transferred into  $\frac{3}{4}$  of the cuvette.

### Preparation of Gallic Acid Standard Solution

To make a 1000ppm stock solution, 0.01g of gallic acid powder was weighed, then dissolved in a volumetric flask with the addition of methanol up to 100ml. Then the working solution was made by taking 10ml of stock solution and putting it into a volumetric flask and adding methanol solvent up to 100ml and then shaking until homogeneous. The working solution was then used to make variations of standard solutions with variations (10, 20, 30, 40, 50) ppm.

The variation solution was then treated the same as the sample solution, where 1ml was taken to be added with 0.5ml of Folin-Ciocalteu reagent into a test tube. The solution was then shaken until homogeneous and left for 8 minutes. Then the solution was added with 4ml of 7% Na<sub>2</sub>CO<sub>3</sub> and vortexed. After vortexing, the solution was transferred into a centrifuge tube to be centrifuged for 5 minutes at a speed of 4.4 rpm. The solution that is separated from the sediment is then transferred into a cuvette up to  $\frac{3}{4}$  of the volume.

### Maximum Wavelength Measurement

A blank was prepared by filling a cuvette with methanol up to three-quarters full. Then, one of the standard solutions with the highest concentration, 50 ppm, was tested using a spectrophotometer to obtain the maximum wavelength. These results were then used to measure the sample's absorbance.

### Standard Solution Graph Measurement

All variations of standard gallic acid solutions of 10ppm, 20ppm, 30ppm, 40ppm, and 50ppm were tested with blanks using a UV-Vis spectrophotometer to see the absorbance measurements.

### Sample Absorbance Measurement

The sample solution that has been prepared in the cuvette is then tested together with a blank as a reference on a UV-Vis spectrometer with previously found wavelength measurements.

The results of the concentration calculation are then used in the analysis to determine the total phenolic content by substituting the concentration value into the formula.

$$TPC = \frac{C.V.FP}{g}$$

TPC: Total Phenolic Content (mg GAE/g)

C: concentration

V: Volume (ml)

F: Dilution Factor

G: Gram

## 3 RESULT

Based on the maximum wavelength measurement, the peak point is known to be at 764 nm. In measuring the absorbance of various standard solutions (10, 20, 30, 40, 50) ppm, the peak point

value is used to analyze the absorbance of various solutions, where the following results are obtained.

Standard	Concentration mg/dL	Absorbance
Standard 1	10	0.3120
Standard 2	20	0.4774
Standard 3	30	0.6349
Standard 4	40	0.8685
Standard 5	50	1.0254

Table 1 Absorbance Values of Standard Solution Variations

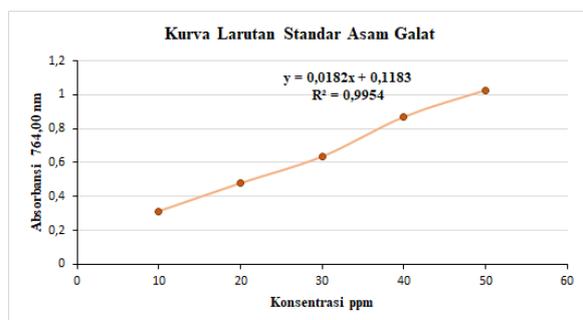


Figure 1 Graph of Variation of Gallic Acid Standard Solution

Based on Measurement of the concentration value of the variation of standard solutions obtained the absorbance value of each solution attached in table 1. This value can then be shown in the graph attached in the graph image.1 where the value of the linear equation resulting from the graph is:

$$y = 0.0182 * x + 0.1183 \text{ with } R^2 = 0.9954.$$

## Absorbance, Concentration, and Total Phenolic Content of Moringa Leaves

Absorbance	Concentration mg/dL	Total Phenolic Content (mg GAE/g)
3.5563	188,9	18,89

Table 2 Absorbance Values, Concentration, and Total Phenolic Content of Moringa Leaves

Based on the measurement of the absorbance value of the moringa leaf sample, it is known that the absorbance value reaches 3.5563, this value is then substituted into the equation  $y = 0.0182 * x + 0.1183$  and the concentration value was obtained at 188.9 mg/L. This concentration value was then used to determine the total phenolic content using the formula (TPC) and it was found that the total phenolic content of Moringa leaves was 18.89 mg/L (mg GAE/g)

## DISCUSSION

### Sample Identification

Known to originate from India, moringa is a plant from the Moringaceae family. This plant can thrive in a variety of climates and soil conditions, making it easily accessible to people worldwide. Moringa grows abundantly in almost every village in tropical countries like Indonesia. One major advantage for the community is the easy availability of moringa leaves, which are an inexpensive and easy-to-prepare ingredient in everyday foods. Various moringa leaf preparations, such as tea, juice, powder, and even foods like pudding and biscuits, add to the healthy food options available to the

general public. Moringa grows widely in tropical regions, from South Asia to West Africa. This plant thrives in temperatures between 25 and 40 degrees Celsius and requires a minimum of 500 mm of rainfall annually. Historically, moringa plants have been used as traditional medicine in India for thousands of years. Moringa plants were also used as cosmetics and food by the Egyptians, Greeks, and Romans. Moringa plants have long been used in various regions of the world, both as a food source and for traditional medicine. The Moringa oleifera plant is attracting increasing attention among researchers, farmers, and health enthusiasts due to its remarkable health benefits. However, to fully appreciate its value and benefits, it is important to understand the history and origins of this plant, which has a rich cultural heritage and widespread use in diverse cultures worldwide (Ruslan, 2024).

## Extraction

Moringa leaves (*Moringa oleifera* Lam.) that has been picked and cleaned is then processed into simple drugs through drying and grinding. The drying process is a crucial step in reducing water content, thus preventing microbial growth and maintaining the stability of bioactive compounds. Various studies have shown that drying methods affect the quality of simple drugs. Research at the University of Jember reported that drying using lamp dryer Drying at a temperature of 40–60 °C produces the best quality simples, characterized by high yield (35.10–35.21%), low water content (10.03–10.13%), bright green colour, and maintained vitamin C (26.48–28.28%) and chlorophyll (18.41–19.25 mg/L) content (Lindriati et al., 2022). Other studies also show that the order of effectiveness of drying in maintaining

bioactive compounds is freeze-drying > air drying > sun drying > oven drying, where oven drying tends to significantly reduce phenolic, flavonoid, and antioxidant activity content (Ademiluyi et al., 2018).

After the drying stage, the dried moringa leaves are then ground into a powder. The grinding process aims to increase the surface area, thus facilitating the extraction of active compounds in subsequent research stages. Research by (Ademiluyi et al., 2018) states that moringa leaf powder ground with a local machine produces a homogeneous powder that is stable when stored in a tightly closed container. The results of the standardization of the powder using the method food dehydrator also showed that the powdered simplex met pharmacopoeia quality parameters such as moisture content, ash content, and organoleptic characteristics (Azizah et al., 2022). Therefore, the combination of the correct drying method and a good grinding process significantly determines the quality of the Moringa leaf simplex as a raw material for research and phytopharmaceutical products.

Leaf extraction *Moringa oleifera* The maceration method using 70% methanol has proven effective in obtaining phenolic compounds. This method was chosen because aqueous methanol has the appropriate polarity to dissolve polyphenolic compounds without damaging their active structure. Recent research shows that maceration with 70% methanol on Moringa leaves can produce a higher total phenolic content than water or absolute methanol extracts. This is because the mixture of methanol and water increases the solvent's penetration ability into plant cell tissue, resulting in more phenolic compounds being extracted (Sugihartini et al., 2022). According to research

(Olaoye et al., 2021), Moringa leaf extract with 70% methanol has a total phenolic content of  $100.11 \pm 10.24 \mu\text{g GAE/mg}$  extract. These results are supported by research (Sugihartini et al., 2022) which found that 70% methanol concentration produced the most optimal phenolic content compared to other methanol concentrations. Thus, the maceration method using 70% methanol can be considered as an efficient approach to obtain moringa leaf extract rich in phenolic compounds which play an important role as natural antioxidants.

Research by (Satriyani, 2021) reported that the methanol extract of Moringa leaves had maximum absorbance at  $\lambda$  270 nm and 430 nm, which indicated flavonoid and chlorophyll pigment content, respectively. The total phenolic content obtained by the Folin–Ciocalteu method and detected using UV-Vis reached 53.64 mg GAE/g extract, while the total flavonoid content was 21.17 mg QE/g extract. These results are in line with research by (Obialo et al., 2024) which showed that the methanol extract of Moringa leaves had absorption peaks in the UV (260–280 nm) and visible (400–450 nm) regions, as well as high antioxidant activity with an  $\text{IC}_{50} < 50 \mu\text{g/mL}$ .

Moringa leaf extract (*Moringa oleifera* Lam.) obtained through a maceration process with 70% methanol solvent has organoleptic characteristics of dark green to brownish green with a thick, paste-like consistency. The distinctive aroma of Moringa leaves is still noticeable although its intensity decreases after the solvent evaporation. This characteristic is in line with research (Pradana & Wulandari, 2019) which reported that the methanol extract of Moringa leaves is dark green with a thick consistency and a distinctive aroma of simple herbals.

Based on the yield calculation results, from 500 grams of dried Moringa leaf powder, 105.4 grams of extract were obtained, resulting in a yield of 21.08% (Yulia et al., 2022). Another study by (Rifkia & Revina, 2023) also showed a yield of 19.5% using the same method and solvent. Differences in yield across studies may be caused by the water content in the powder, the size of the powder particles, the length of the maceration time, and the solvent evaporation temperature. This indicates that the maceration method using 70% methanol is quite effective in extracting bioactive compounds from Moringa leaves.

### Principles of Analysis Methods

Determination of total phenolic content in Moringa leaf extract can be performed using the Folin–Ciocalteu method. In principle, phenolic compounds will react with phosphomolybdate-phosphotungstate reagents in alkaline conditions to form a blue complex, the intensity of which is proportional to the amount of phenolic compounds in the sample. The blue colour is then measured using a UV-Vis spectrophotometer at a wavelength of around 764–765 nm, with the results expressed as gallic acid equivalents (GAE). Research results (Guntarti et al., 2021) showed that 50% ethanol extract of Moringa leaves from several growing locations produced total phenolic content ranging from 99.40–142.92 mg GAE/g dry extract using this method.

Another study by (Verawati et al., 2020) also proved that the combination of maceration and ultrasonication methods with 70% ethanol solvent was able to produce a total phenolic content of up to 82.87 mg GAE/g extract, while (Sari, 2024) reported a total phenolic content of the methanol fraction of

moringa leaves of 126.52 mg/kg GAE. These differences in results may be influenced by the type of solvent, extraction method, and environmental conditions where the plant grows, but in general, they consistently show that moringa leaves are rich in phenolic compounds that act as natural antioxidants.

In the Folin–Ciocalteu method, phenolic compounds contained in Moringa leaf extract are reacted with phosphomolybdate–phosphotungstate reagent in alkaline conditions, forming a blue complex whose colour intensity is proportional to the amount of phenolic compounds. The absorbance of this blue complex is measured using a UV-Vis spectrophotometer at a wavelength of approximately 764–765 nm, then compared with a gallic acid calibration curve. The results are expressed in units of mg Gallic Acid Equivalent per gram of extract (mg GAE/g extract), or the equivalent in the form of  $\mu\text{g}$  GAE/g extract when converted to the microgram scale. This method has proven reliable in reproducibly quantifying total phenolics in various plant extracts.

In a study by (Guntarti et al., 2021) reported that 50% ethanol extract of Moringa leaves originating from three different locations Sleman, Wonosari, and Wonosobo contained total phenolic levels of  $(127.87 \pm 2.71)$ ,  $(99.40 \pm 2.68)$ , and  $(142.92 \pm 1.81)$  mg GAE/g extract, respectively, which were measured using Folin–Ciocalteu reagent and gallic acid standard. In addition, (Fachriyah et al., 2020) stated that the ethanol extract of *M. oleifera* leaves had a total phenolic content of 63.16 mg GAE/g extract. The microgram ( $\mu\text{g}$ ) scale can be used if the results are to be displayed in a smaller range, for example 63.16 mg GAE/g is equivalent to 63,160  $\mu\text{g}$  GAE/g extract.

Based on the results of absorbance measurements at a wavelength of 764 nm, the concentration of moringa leaves was 188.9 mg/L with a total phenolic content of 18.89 mg GAE/g. This average total phenolic content is in line with previous studies that reported that moringa leaves contain significant amounts of phenolic compounds, which contribute to their antioxidant activity. This high phenolic content indicates strong antioxidant potential, considering that phenolic compounds are known to neutralize free radicals and protect cells from oxidative stress. Therefore, moringa leaves can be considered an effective natural source of antioxidants and have the potential to be used in the development of health products and functional nutrition.

The total phenolic content of Moringa leaves was 18.89 mg GAE/g, indicating a high value. This result is higher than the study (Qonitah et al., 2024), which reported  $19.513 \text{ mg GAE/g} \pm 0.019$ , compared to the ethanol extract of Moringa bark, which was  $4.835 \text{ mg GAE/g} \pm 0.008$ . This difference in figures is mainly influenced by differences in units and measurement methods. In general, high phenolic content is usually associated with stronger antioxidant activity. Research (Tjong et al., 2021) based on literature studies also showed that fractions with higher phenolic content have lower IC<sub>50</sub>s, thus better antioxidant activity. Meanwhile, (Riskianto et al., 2021) found moderate antioxidant activity in 70% ethanol extract with an IC<sub>50</sub> of around 50.6  $\mu\text{g/mL}$ , although they did not report specific phenolic levels. The high phenolic content in the test data has the potential to indicate strong antioxidant power.

The high phenolic content in moringa leaves demonstrates the plant's significant potential for

development as a functional food, supplement, or herbal remedy effective in improving health. The high phenolic content acts as a powerful antioxidant that can protect the body from oxidative damage and various degenerative diseases (Amin & Lidiasari, 2025). This provides strong scientific support for the claim of moringa leaves as a beneficial "superfood." Developing moringa leaf-based products can expand public access to safe and affordable sources of natural antioxidants (Eriyahma, 2023). Therefore, further research and product standardization are crucial to optimize the potential of moringa leaves as a functional food and medicinal ingredient. Limitations and directions for further research

This study was limited to analysing the total phenolic content of *Moringa oleifera* leaves using the Folin–Ciocalteu method, thus only estimating the total phenolic content without providing information on the type or profile of individual compounds. This method, although practical and rapid, is non-selective and can react with other reducing compounds such as tannins, saponins, and other aromatic compounds, which means that the total phenolic content obtained does not fully reflect the pure phenolics in the extract. Furthermore, recent studies that still focus on total phenolic content also show significant variation in results depending on the extraction method and solvent composition. Furthermore, previous studies also reported significant variation in total phenolic content in *Moringa* leaves, depending on the extraction method and type of solvent used.

Research by (Royani et al., 2023) found that *Moringa* leaf extract with 50%, 75%, and 100% methanol produced significantly different total phenolic levels, namely 12.33% to 16.26%. Meanwhile, (Boudoukha et al., 2024) reported a total

phenolic value of  $100.11 \pm 10.24$   $\mu\text{g GAE/mg}$  in the methanol extract, which is much higher than the water extract. These differences in results indicate that total phenolic data are greatly influenced by extraction conditions and solvents, so the generalization of the research results is still limited.

Furthermore, this study did not include an evaluation of the biological activity of the obtained extracts. Direct antioxidant activity testing, for example using the DPPH or ABTS methods, is necessary to determine the actual free radical scavenging capacity. Furthermore, isolation and identification of active compounds using chromatography techniques (HPLC/LC-MS), as well as *in vivo* testing in animal models, are crucial to demonstrate the efficacy and safety of moringa leaf bioactive compounds in more complex biological systems (Chaves et al., 2020)

## 4 CONCLUSIONS

Based on this research, *Moringa* leaf extract contains phenolic compounds so it has the potential to be an antioxidant and is beneficial for health, the total phenolic content of the extract methanol *Moringa* leaves using the UV-Vis spectrophotometer method with Folin-Ciocalteu reagent and gallic acid standard, it was found that the concentration calculation was then used in the analysis to determine the total phenolic content, where 10mg or 0.01g of *Moringa* leaf extract contained 18.89 mg GAE/g. Thus, *Moringa* leaves can be considered as a natural source of effective antioxidants and have the potential to be used in the development of health products and functional nutrition. The potential of *Moringa* leaves as a natural source of antioxidants is closely related

to the levels of phenolic compounds. Moringa contains significant amounts of phenolic compounds, which contribute to its antioxidant activity. The high phenolic content indicates strong antioxidant potential, considering that phenolic compounds are known to be able to neutralize free radicals and protect cells from oxidative stress.

## 5 REFERENCES

- Ademiluyi, A. O., Aladeselu, O. H., Oboh, G., & Boligon, A. A. (2018). Drying alters the phenolic constituents, antioxidant properties,  $\alpha$ -amylase, and  $\alpha$ -glucosidase inhibitory properties of Moringa (*Moringa oleifera*) leaf. *Food Science & Nutrition*, 6(8), 2123–2133.
- Amin, S., & Lidiasari, A. L. (2025). ANALISIS SENYAWA BIOAKTIF DAUN KELOR (*MORINGA OLEIFERA L.*) SEBAGAI AGEN HIPOKOLESTEROLEMIK POTENSIAL. *Journal of Public Health Science*, 2(2), 166–171.
- Azizah, M. N., Ningsih, A. W., & Sinaga, B. (2022). STANDARISASI SIMPLISIA DAUN KELOR (*Moringa oleifera L.*) DARI DESA LUWUNG SIDOARJO DENGAN MENGGUNAKAN PENGERINGAN FOOD DEHYDRATOR. *Jurnal Penelitian Farmasi Dan Herbal*, 5(1), 76–85.
- Boudoukha, C., Nouioua, W., Amor, L., & Elmastaş, M. (2024). *Phenolic content and antioxidant activity of Moringa oleifera leaf extracts*.
- Chaves, N., Santiago, A., & Alfás, J. C. (2020). Quantification of the Antioxidant Activity of Plant Extracts: Analysis of Sensitivity and Hierarchization Based on the Method Used. *Antioxidants*, 9(1), 76.
- Dising, J. (2024). Identifikasi Senyawa Metabolit Sekunder Dalam Ekstrak Biji Kelor (*Moringa Oleifera L.*) Yang Berpotensi Sebagai Antioksidan. *Partner*.
- Eriyahma, A. (2023). UPAYA PEMANFAATAN DAUN KELOR: PUDDING DAUN KELOR UNTUK MENCEGAH STUNTING. *ABDI MASSA: Jurnal Pengabdian Nasional (e-ISSN: 2797-0493)*, 3(03), 23–27.
- Fachriyah, E., Kusriani, D., Haryanto, I. B., Wulandari, S. M. B., Lestari, W. I., & Sumariyah, S. (2020). Phytochemical Test, Determination of Total Phenol, Total Flavonoids and Antioxidant Activity of Ethanol Extract of Moringa Leaves (*Moringa oleifera Lam.*). *Jurnal Kimia Sains Dan Aplikasi*, 23(8), 290–294.
- Guntarti, A., Sugihartini, N., Umadiyah, S. A., & Salamah, N. (2021). Determination of Total Phenolic Levels in Ethanol Extract of Moringa (*Moringa oleifera L.*) Leaves based on Differences in Growing Sites. *Journal of Food and Pharmaceutical Sciences*, 403–411.
- Janitra, H., Triastuti, J., & Sulmartiwi, L. (2025). Potential of Hairy Cockle's (*Anadara antiquata*) Meat Extract as Antioxidant Compound. *Journal of Marine and Coastal Science*, 14(1), 45–57.
- Juniasti, A., & Sagala, Z. (2021). Uji Penetapan Kadar Total Fenolik dan Nilai SPF (Sun Protection Factor) Ekstrak Etanol Daun Kelor (*Moringa Oleifera L.*) *INDONESIA NATURAL RESEARCH PHARMACEUTICAL JOURNAL*, 6(2), 43–50.

- Khairi, W., Widodo, G. P., Harmastuti, N., Safwan, S., Wahid, A. R., Hendriyani, I., & Ittiqo, D. H. (2025). Identifikasi Senyawa Metabolit Sekunder pada Ekstrak dan Fraksi Ekstrak Daun Kelor (*Moringa oleifera*) dengan Metode Kromatografi Lapis Tipis (KLT). *Lambung Farmasi: Jurnal Ilmu Kefarmasian*, 6(2), 136–140. <https://doi.org/10.31764/lf.v6i2.30257>
- Lindriati, T., Belgis, M., & Annisafitri. (2022). THE APPLICATION OF LAMP DRYER ON PRODUCTION OF MORINGA (*MORINGA OLEIFERA*) LEAF FLOUR. *Jurnal Pangan Dan Agroindustri*, 10(2).
- Maharan, A. D., Amin, S., Fauzan, N. N., & Sopiyan, N. (2025). Peran Senyawa Bioaktif Tumbuhan untuk Penyakit Degeneratif: Tinjauan Kimia Medisinal. *Jurnal Ilmiah Kedokteran Dan Kesehatan*, 4(2), 187–197.
- Musyarpah, R., & Cahyanto, T. (2025). Studi Pemanfaatan Tanaman Kelor (*Moringa oleifera*) Sebagai Pengobatan Tradisional di Kampung Cibeas Desa Cintaraja Kecamatan Singaparna Kabupaten Tasikmalaya. *Flora : Jurnal Kajian Ilmu Pertanian Dan Perkebunan*, 2(1), 44–54.
- Obialo, O. S., Kolawole, A. E., Adetola, J.-O., Obialo, O. S., Kolawole, A. E., & Adetola, J.-O. (2024). Phytochemical Screening of *Moringa oleifera* Leaf Extracts under Different Solvents. *International Journal of Aquaculture and Fishery Sciences*, 10(4), 066–072.
- Olaoye, A. B., Ologunde, C. A., Molehin, O. R., & Nwankwo, I. (2021). Comparative Antioxidant Analysis of *Moringa oleifera* Leaf Extracts from South Western States in Nigeria. *Future Journal of Pharmaceutical Sciences*, 7(1), 68.
- Pradana, D. L. C., & Wulandari, A. A. (2019). Uji TOTAL FLAVONOID DARI EKSTRAK AIR AUN KELOR (*Moringa oleifera*) DAN SECANG (*Caesalpinia sappan* L.). *Jurnal Insan Farmasi Indonesia*, 2(2), 271–277.
- Putri, N. S., Limanan, D., Yulianti, E., & Ferdinal, F. (2024). Perbandingan Uji Kapasitas Total Antioksidan Ekstrak Daun Kelor dengan Metode DPPH, FRAP, dan ABTS. *Jurnal Sehat Indonesia (JUSINDO)*, 6(02), 869–877.
- Qonitah, F., Ramadhan, N. U., & Ariastuti, R. (2024). Uji Kandungan Fenolik Total Ekstrak Etanol Daun dan Kulit Batang Kelor (*Moringa Oleifera*). *FASKES: Jurnal Farmasi, Kesehatan, Dan Sains*, 2(1), 136–143.
- Rifkia, V., & Revina, R. (2023). Pengaruh Variasi Bahan: Pelarut dan Lama Ekstraksi Ultrasonik dari Ekstrak Daun Kelor terhadap Rendemen dan Kadar Total Fenol. *JFIOnline / Print ISSN 1412-1107 / e-ISSN 2355-696X*, 15(1), 94–100.
- Riskianto, Kamal, S. E., & Aris, M. (2021). Aktivitas Antioksidan Ekstrak Etanol 70% Daun Kelor (*Moringa oleifera* Lam.) terhadap DPPH. *Pro-Life*, 8(2), 168–177.
- Royani, A., Hanafi, M., Lotulung, P. D. N., Julistiono, H., Dinoto, A., & Manaf, A. (2023). Analysis of the Antibacterial Activity and the Total Phenolic and Flavonoid Contents of the *Moringa oleifera* Leaf Extract as an Antimicrobial Agent against *Pseudomonas aeruginosa*. *Scientifica*, 2023, 5782063.

- Ruslan, M. G. & Z. A. (2024). *Tentang Kelor*. CV Jejak (Jejak Publisher).
- Salu, V., Bernandus, B., & Bukit, M. (2016). KAJIAN AWAL SPEKTRUM SERAPAN SENYAWA HASIL EKSTRAK DAUN KELOR (MORINGAOLEIFERA L) ASAL KELOMPOK USAHA BERSAMA (KUB) MARUNGA PAH METO KABUPATEN TTU. *Jurnal Fisika: Fisika Sains Dan Aplikasinya*, 1(2), 84–92.
- Sari, T. (2024). Pengaruh Perbedaan Metode Ekstraksi terhadap Aktivitas Antioksidan dan Kadar Fenolat Total dalam Ekstrak Daun Kelor (Moringa oleifera Lam.). *PHARMACY: Jurnal Farmasi Indonesia (Pharmaceutical Journal of Indonesia)*.
- Satriyani, D. P. P. (2021). Review artikel: Aktivitas Antioksidan Ekstrak Daun Kelor (Moringa oleifera Lam.). *Jurnal Farmasi Malahayati*, 4(1), 31–43.
- Sedjati, S., Supriyantini, E., Wulandari, S. Y., & Sulastri, N. I. (2023). Peningkatan Kadar Fenolik Total dari Chlorella sp. Menggunakan Cekaman Radiasi Ultraviolet-B. *Jurnal Kelautan Tropis*, 26(1), 49–58.
- Sugihartini, N., Nur, M. U., & Yuliani, S. (2022). The Effect of Methanol Concentration on the Extraction of Moringa Leaf (Moringa oleifera) and Papaya Fruit (Carica papaya) on Elastase and Hyaluronidase Installing Activities. *Open Access Macedonian Journal of Medical Sciences*, 10(A), 1463–1470.
- Tjong, A., Assa, Y. A., & Purwanto, D. S. (2021). Kandungan Antioksidan Pada Daun Kelor (Moringa Oleifera) dan Potensi Sebagai Penurun Kadar Kolesterol Darah. *eBiomedik*, 9(2).
- Verawati, V., Sari, T. M., & Savera, H. (2020). Pengaruh Perbedaan Metode Ekstraksi terhadap Aktivitas Antioksidan dan Kadar Fenolat Total dalam Ekstrak Daun Kelor (Moringa oleifera Lam.). *PHARMACY: Jurnal Farmasi Indonesia (Pharmaceutical Journal of Indonesia)*, 90–97.
- Wulandari, D., Amin, S., Anamareri, N. A., & Azizah, A. (2025). Tinjauan Kimia Medisinal Senyawa Fenol dari Ekstrak Daun dan Biji Pepaya (Carica papaya) sebagai Anti Kanker. *Jurnal Ilmiah Kedokteran Dan Kesehatan*, 4(2), 132–146.
- Yulia, Y., Idris, M., & Rahmadina, R. (2022). Skrining Fitokimia dan Penentuan Kadar Flavonoid Daun Kelor (Moringa oleifera L.) Desa Dolok Sinumbah dan Raja Maligas Kecamatan Hutabayu Raja. *KLOROFIL: Jurnal Ilmu Biologi Dan Terapan*, 6(1), 49–56.